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MICHAEL JOHN MALLON

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Supervisor: Dr. Richard Reeves

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ABSTRACT

This thesis concerns the acquisition of newly developed production equipment in factories. Types of Manufacturing Technology Acquisition (MTA) can range from in-house development through to outright purchase from a supplier. MTA projects often fail because the new equipment fails to perform well enough or the expected financial benefits are not achieved. The purpose of this research has been to find out how to select the right manufacturing technology acquisition projects, and having chosen them, how to make them successful.

Very little guidance on this subject was found in the literature. Therefore the approach taken was to adapt techniques widely used in the much more deeply researched field of New Product Development (NPD). The Success Factor method was applied by conducting interviews with managers in a number of factories to develop lists of factors thought to affect success or failure in their MTA projects. The Portfolio method from NPD was adapted to the case of managing a total MTA budget, and developed through its use in three annual cycles of equipment acquisition in the researcher's Company. A formula for Expected Commercial Value in NPD was modified to become Expected Manufacturing Benefit, and tried out in practice. An important consideration in manufacturing equipment projects was discovered to be the replication of projects which had proved successful, and ways to incorporate this factor into the project selection procedure were developed. A detailed case study of a single project was carried out, which verified the validity of the findings at the level of a single project. This case study also revealed the considerable impact that corporate strategic events can have on technology acquisitions. This led to a case study on corporate strategy in the Company being carried out.

Finally the findings were brought together to present a complete model for managing MTA.

ACKNOWLEDGMENTS

Completing a Ph.D. while employed in a demanding full-time role has been rewarding but difficult. I am particularly grateful to the sponsoring company, Fruit of the Loom International Limited, for giving me the necessary support to complete this part-time research project.

I would like to thank my colleagues and friends who have supported and encouraged me throughout the entire research period. Moral support is essential to the part-time researcher – there are times when you wish you had never started but have already invested too much time to give up! My family and colleagues were particularly helpful through these difficult periods.

The survey work of other managers' experiences in undertaking Manufacturing Technology Acquisition outside of the Company was an important element of this research work, as was the involvement of those employees within Fruit of the Loom in the two internal case studies. I would like offer my appreciation to all those who actively participated in these studies.

Arranging regular meetings with my supervisor, Dr. Richard Reeves, was not always easy due to the severe demands on both our times from our day-to-day work. It was necessary for some review meetings to take place at the researcher's factory, in order to see the research work in its context within the manufacturing facilities, and to review progress with the sponsors. I would like to thank Dr. Reeves for his flexibility in facilitating this. In addition, I am indebted to Dr. Reeves for his patience, understanding and continuous encouragement and guidance, without which it would not have been possible to complete this research work.

I would like to sincerely thank the following people for their support and assistance in this research project;

My review panel, Professor Barrie Moss and Professor Keith Goffin, who both challenged and advised me at the student review meetings. Professor Tom Allen (MIT) and Professor Eric Beatty, OBE, (QUB), who afforded me the time to discuss my research ideas in detail, particularly in the early stages of the project. Fellow student, Dr. Leslie Falkingham, with whom I shared many ideas and concepts on the subject of Technology Management. Seamus Boyle, for reviewing

the work as it neared completion. My work colleagues Liam Tourish, Eugene McIlroy, Martin Quigley, Frank Gallagher, Andy McCarter, Austin Cutliffe and Catriona Kelly, for their encouragement at various stages during the seven years. In particular, I am indebted to Joe Mullan, Senior Vice President of Manufacturing, who not only made this all possible, but who actively pushed the work forward and facilitated the researcher's every request. His vision ensured its completion.

Finally, and most importantly, I would like to thank my family for their support during the many years of long evenings and weekends they had to spend on their own, while I worked on this research. This thesis is dedicated to my wife, Paula, my daughter, Maeve – who arrived half way through the research – and to my mother, Marie.

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Chapter 1

Introduction.

1.0 Introduction to Manufacturing Technology Acquisition

This thesis describes research in the field of Manufacturing Technology Acquisition (MTA)[1]. The research examines what factors contribute to success or failure when acquiring manufacturing technology and what measures can be used to determine whether or not the acquisition is successful. Furthermore, it examines project selection methods and the use of portfolio management techniques (a range of methods adopted from the field of new product research & development) in managing a firm's MTA projects. Finally a new model for acquiring manufacturing technology is presented.

In order to establish or maintain a competitive market position, manufacturing organisations continue to invest in new technology and innovations. However, there is a growing body of evidence which suggests that many companies fail in their endeavours to successfully acquire and implement manufacturing technologies at a project level (Thurow (1987), Tyre (1991) and Chung (1996)). Despite the recognition of problems associated with the acquisition of manufacturing technology, advice in the literature on how to undertake this activity successfully is very limited. Whilst the researcher's Company had carried out many successful MTA projects, it had also experienced many examples of failed projects.

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[1] MTA is an acronym developed by the researcher and is used throughout this thesis for the term Manufacturing Technology Acquisition.

1.1 Background

Why was the theme of Manufacturing Technology Acquisition chosen as an area for research? The main influence was the responsibility of the researcher in his full-time employment with Fruit of the Loom International Limited, a major textile and apparel company. At the time of starting the research in October 1995 the researcher was employed as Research and Development (R&D) Manager for the European manufacturing division of this Company, and had direct responsibility for developing and acquiring new manufacturing technology for the group. The researcher had held this position since May 1994, having previously worked as a Senior Industrial Engineer in the Company from 1990.

Senior management in the Company wanted to improve the process for acquiring manufacturing technology, whether the technology was acquired through external means, for example, from machine suppliers, or developed in-house through internal R&D efforts. Although the manufacturing group had completed many successful technology acquisition projects over the preceding years there were also many examples of failed acquisitions or projects where the full anticipated benefits of the technologies were not achieved. Fruit of the Loom undertook to sponsor this research project, anticipating the development of an improved and more robust MTA process.

The initial review of the literature lent support to the view that research in the field of MTA was limited. Several authors (e.g. Leonard-Barton (1991), Tyre (1991), Pisano & Wheelwright (1995), Ramamurthy (1995)) had addressed specific aspects or components of MTA such as the implementation phase, project selection, process development, planning, and so forth, but no literature was available which addressed the overall process in a way which would satisfy the basic research questions or objectives, or indeed the needs of the sponsoring Company.

It was evident that a significant body of research work and publications were available in the complementary field of New Product Development (NPD).[2] Most companies' R&D efforts are geared towards developing new products whereas the primary objective of the R&D unit in Fruit of the Loom was aimed more at manufacturing process development activities through technology acquisition.

Many of the publications in the field of R&D and NPD offered practical "whole-process" models and techniques for undertaking R&D activity in organisations. Roussel *et al* (1991) developed Portfolio Management techniques for selecting new product projects in companies. Cooper (1993) proposed a methodology known as "Stage-Gate" for managing new product projects. Cooper *et al* (1998) later focused entirely on Portfolio Management for new products, dealing with resource allocation, project selection and prioritisation in firms at a detailed level. They also studied how to reconcile portfolio project selection procedures with stage-gate project management procedures.

The adaptation, implementation and testing-out of techniques from the field of NPD to the field of MTA forms a significant part of this thesis.

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[2] NPD is an acronym used widely in the literature to denote New Product Development activities.

1.1.1 Background on Fruit of the Loom

The Company's official website[3] provides an excellent description of the Company's activities, as follows:

> "The Company is a leading international, vertically-integrated basic apparel company, emphasising branded products for consumers ranging from infants to senior citizens. The Company is one of the largest producers of men's and boys' underwear, activewear for the screenprint Tee shirt and fleece market, women's and girls' underwear, casualwear, and childrenswear, selling products principally under the FRUIT OF THE LOOM®, BVD®, SCREEN STARS®, and BESTTM brand names. In addition, the Company markets a wide assortment of graphically decorated products.
>
> The Company is a fully integrated manufacturer, performing most of its own yarn spinning, knitting, cloth finishing, cutting, sewing and packaging. Management considers the Company's primary strengths to be its excellent brand recognition, low cost production resulting primarily from the offshore location of substantially all of its labour-intensive manufacturing operations, and strong relationships with major discount chains and mass merchandisers. Management believes that consumer awareness of the value, quality and competitive prices of the Company's products will benefit the Company in any retail environment where consumers are value conscious.
>
> The Company has organised its business into three areas: (1) retail products (50% of 1998 net sales); (2) activewear (38%); and (3) European business (12%). The products included in the retail business are generally sold to major discount chains and mass merchandisers and consist of (i) men's and boys' underwear; (ii) women's and girls' underwear; (iii) domestic casualwear (i.e., undecorated or "blank") Tee shirts and fleecewear; (iv) international casualwear Tee shirts, 70% of which are sold in Canada, 16% in Mexico and 14% in Japan; and (vi) childrenswear. The products included in the activewear business are sold to large wholesale distributors, who break down bulk purchases for resale to the screenprint market and speciality retailers, and consist primarily of Tee shirts and fleecewear. European apparel product offerings generally consist of Tee shirts, fleecewear and polo shirts sold to wholesale distributors for resale to the imprint market[4] (63%) and sold to the retail market (37%). These products are sold primarily in Western European countries. Within its three business areas, the Company produces a wide range of basic apparel products and believes that

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[3] Fruit of the Loom's official website is http:\\www.fruit.com

[4] Imprint Market refers to the segment of business where the Company sells its basic tee shirts to printers who then embellish the products with a "print" on the front and/or back of the garment before selling on.

> price, product quality and responsive delivery are the most important factors in the sale of these products.
>
> The Company's business strategy and the primary basis upon which it competes are first and foremost based on the principle of low cost manufacturing. The Company's strategy is to use its automated textile manufacturing facilities in the United States for yarn spinning, knitting, bleaching and dyeing, together with low cost offshore operations for labour-intensive cutting, sewing and finishing activities. This combination allows the Company to optimise its cost-structure and offer continued value to its customers. As part of this strategy, over the last three years the Company transferred substantially all of its sewing operations to locations in Mexico, the Caribbean and Central America. In 1998, over 95% of the Company's garments were sewn off shore, as compared to approximately 12% at the beginning of 1995. The Company estimates that, as a result of the movement of its sewing operations offshore, assembly costs have been reduced by more than $150 million annually. Based on the Company's selling price points and operating margins on its various products, management believes that the Company is one of the lowest cost producers in the markets it serves.
>
> The Company extensively markets its activewear and, to a lesser extent, other products outside the United States, principally in Europe, Canada, Japan and Mexico. In order to serve these markets, the Company has manufacturing plants in Canada, the Republic of Ireland and Northern Ireland (United Kingdom), as well as manufacturing operations in Morocco where cut fabrics from the Republic of Ireland are sewn and returned to Europe for sale."

Today, Fruit of the Loom (FTL)[5] employs 23,000 people worldwide and has an annual turnover of US$1,900 million. The Company was acquired in April 2002 (Appendix A (i)) by Berkshire-Hathaway Inc, one of the world's leading conglomerates, headed up by the legendary investor Warren Buffet.

Further information on both Berkshire Hathaway and Fruit of the Loom can be obtained on the following websites:

(1.) http://www.fruit.com

(2.) http://www.fruitoftheloom.com

(3.) http://www.berkshire-hathaway.com

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[5] FTL is the abbreviation used throughout this thesis to denote Fruit of the Loom.

Fruit of the Loom's European manufacturing operations began in 1987 when a relatively small family-owned textile firm based in the Northwest of Ireland, W.P.McCarter and Company, signed a joint venture deal with the U.S. multinational. At that time the McCarter Company employed around 400 people in Buncrana, County Donegal, but it had recognised that to survive, it needed to form a strategic alliance with a major global textile business. It achieved this objective, as Fruit of the Loom wanted to grow its business significantly in Europe, which at this stage represented only a small level of export sales. It had no European manufacturing presence. In 1989, Fruit of the Loom purchased the family owned business outright and expanded its manufacturing and sales base in Europe aggressively over the next decade. Employee numbers in Europe rose from 400 in 1987 to 3,500 by 1997, and sales in Europe had grown from US$30 million to US$271 million by 1995. To support this sales growth the manufacturing facilities had multiplied from one plant in 1987 to nine by 1996. The European operations, especially manufacturing, had experienced significant growth and investment during this period. Today the Company has three textile manufacturing facilities[6] in the north-west of Ireland, one in Campsie and two in Buncrana (Figure 1.1)

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[6] The Researcher is currently the Manufacturing Director for the three textile plants in Ireland. Later in the thesis, it is explained how the nine plants became reduced to three.

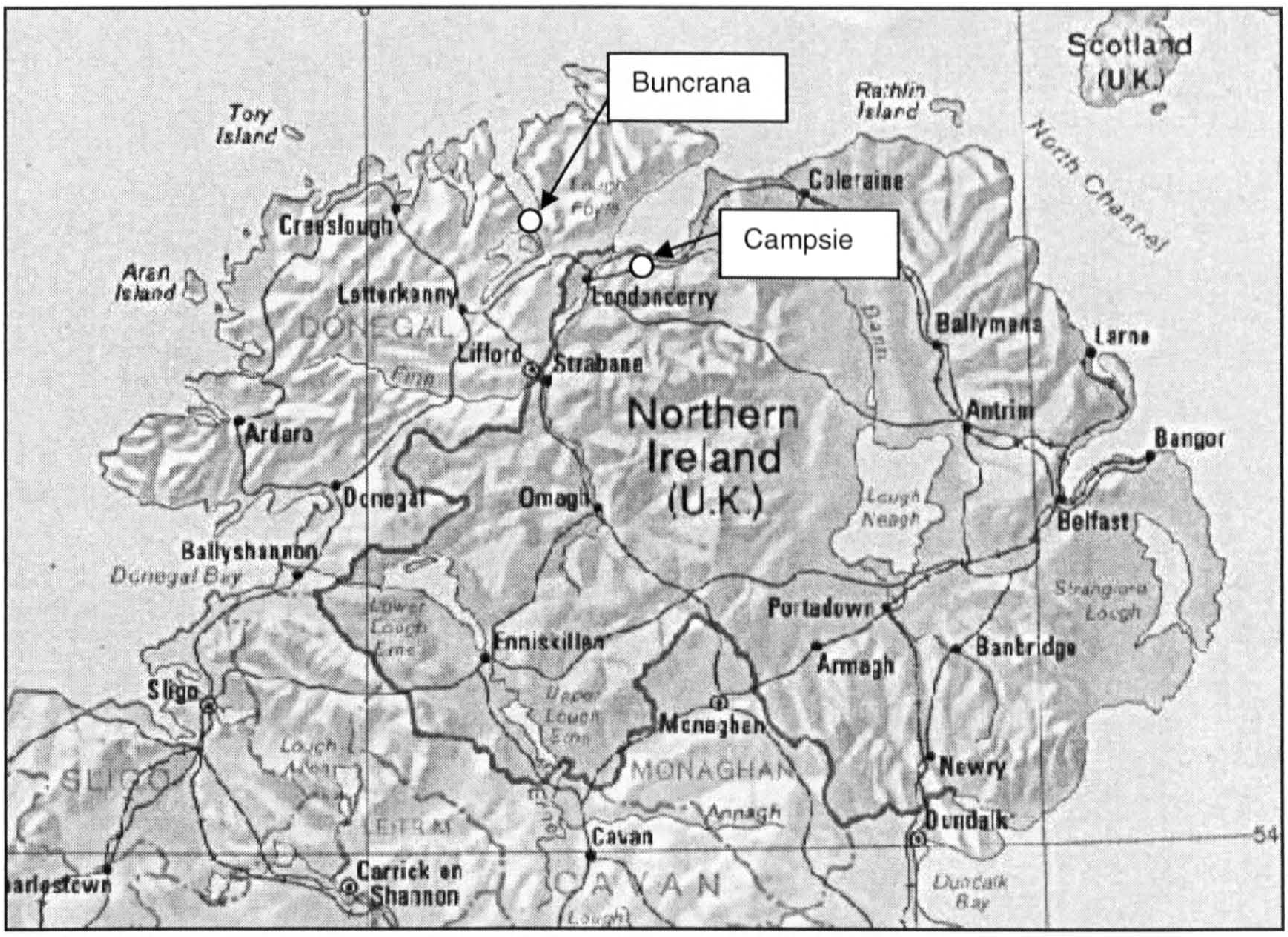


Figure 1.1: Map of Northern Ireland showing the locations of the manufacturing facilities at Campsie and Buncrana.

1.1.2 An Overview of the Manufacturing Process in Fruit of the Loom in 2002

In order to understand the type of technology deployed within the Company and the technology acquisition challenges, a brief overview of the manufacturing processes is now given for the European operations (the manufacturing process is very similar in the U.S.).

Firstly, cotton and polyester are purchased as the primary raw materials. The cotton for use in the European market is acquired from suppliers in Australia, Greece and the U.S. The average weekly consumption rate in 2002 is budgeted at 400,000 kg. The cotton is converted into yarn (i.e. thread) via a number of processes at a 475,000 square foot spinning mill in Campsie, Northern Ireland (Figure 1.2), operating 24 hours per day, 7 days per week. This is a highly automated facility and is the largest yarn mill in Western Europe.

Figure 1.2: FTL spinning mill, Campsie, Northern Ireland.

The actual spinning process itself rotates the cotton fibres at 120,000 rpm to form the yarn (Figures 1.3 & 1.4).

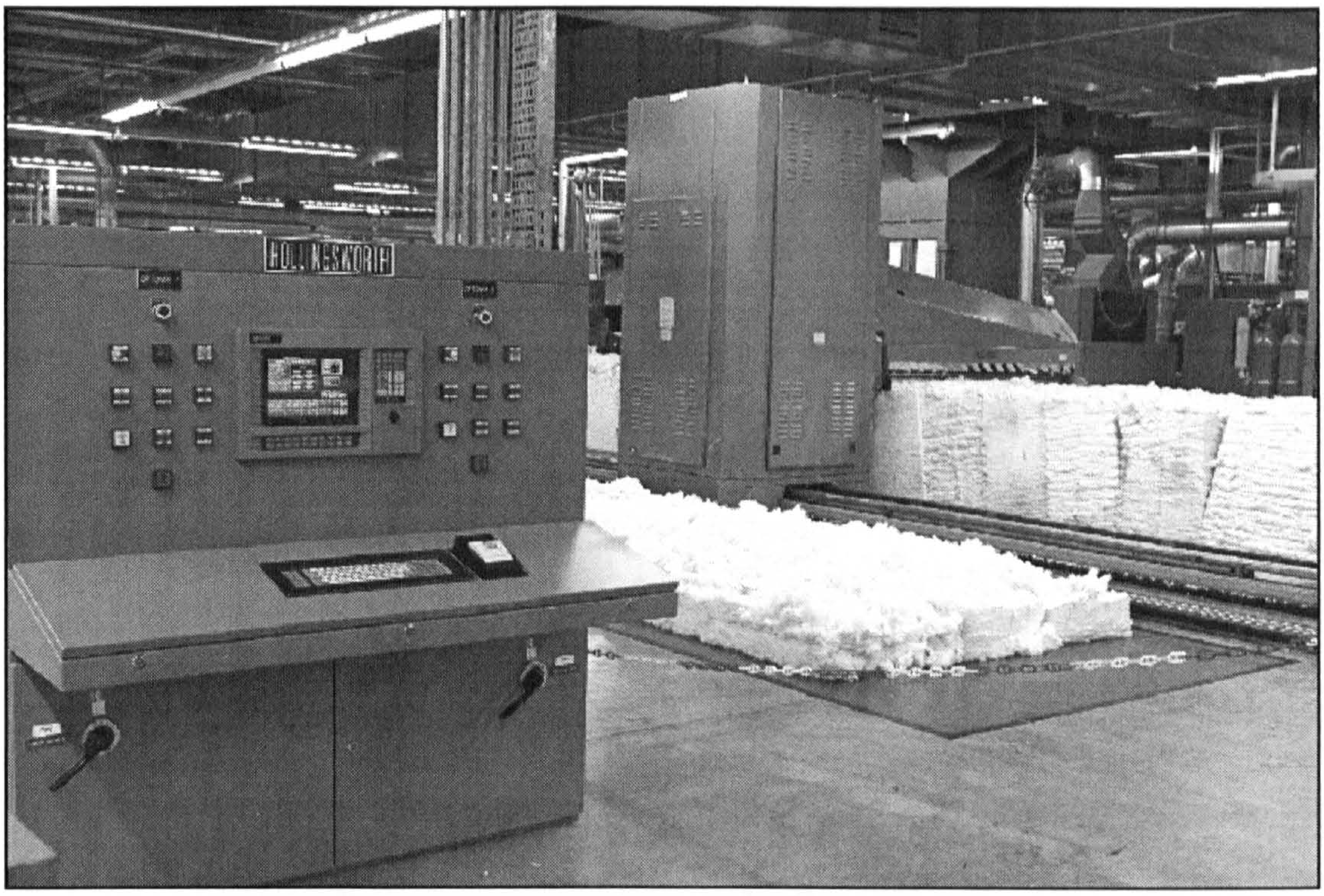


Figure 1.3: The first stage in the manufacturing process, the cleaning of cotton fibre.

Figure 1.4: Some of the 51 spinning machines used to form yarn at the Campsie Mill in N.Ireland.

The yarn is then converted into fabric at the Company's knitting facilities in Campsie, Northern Ireland and in Donegal, Republic of Ireland, where a total of over 200 hundred automated machines (Figure 1.5) are used to create the fabric.

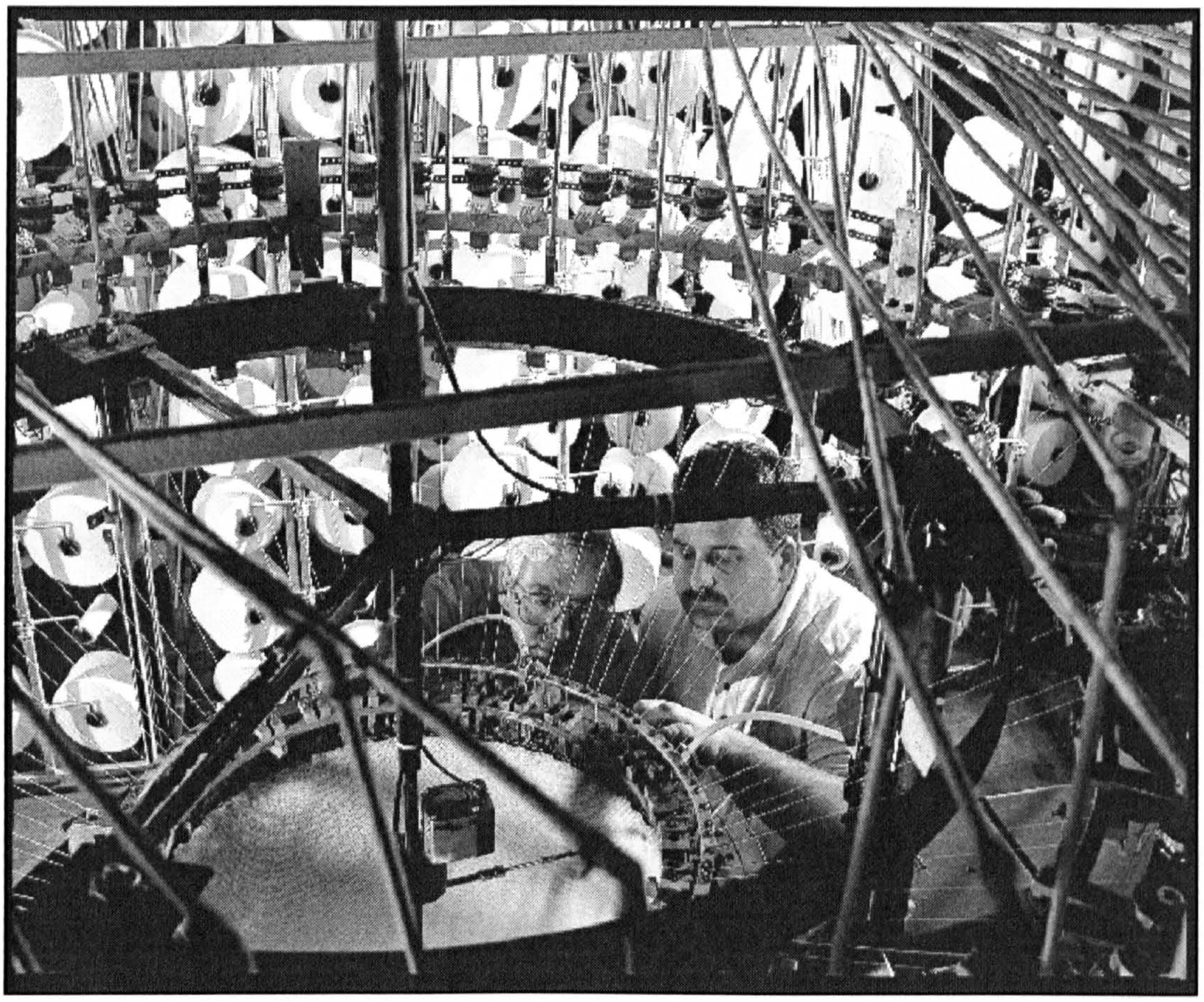


Figure 1.5: Automated knitting machines which convert yarn into fabric.

Next, the fabric is bleached or dyed to a specific colour in the dyeing plants in the Republic of Ireland (Figures 1.6 & 1.7). The two dyeing facilities are highly automated with specialist technology acquired from Europe, the U.S. and Israel being employed in this complex process (Figures 1.8 and 1.9).

Figure 1.6: FTL's knitting & dyeing plant
at Shore Road, Buncrana, County Donegal.

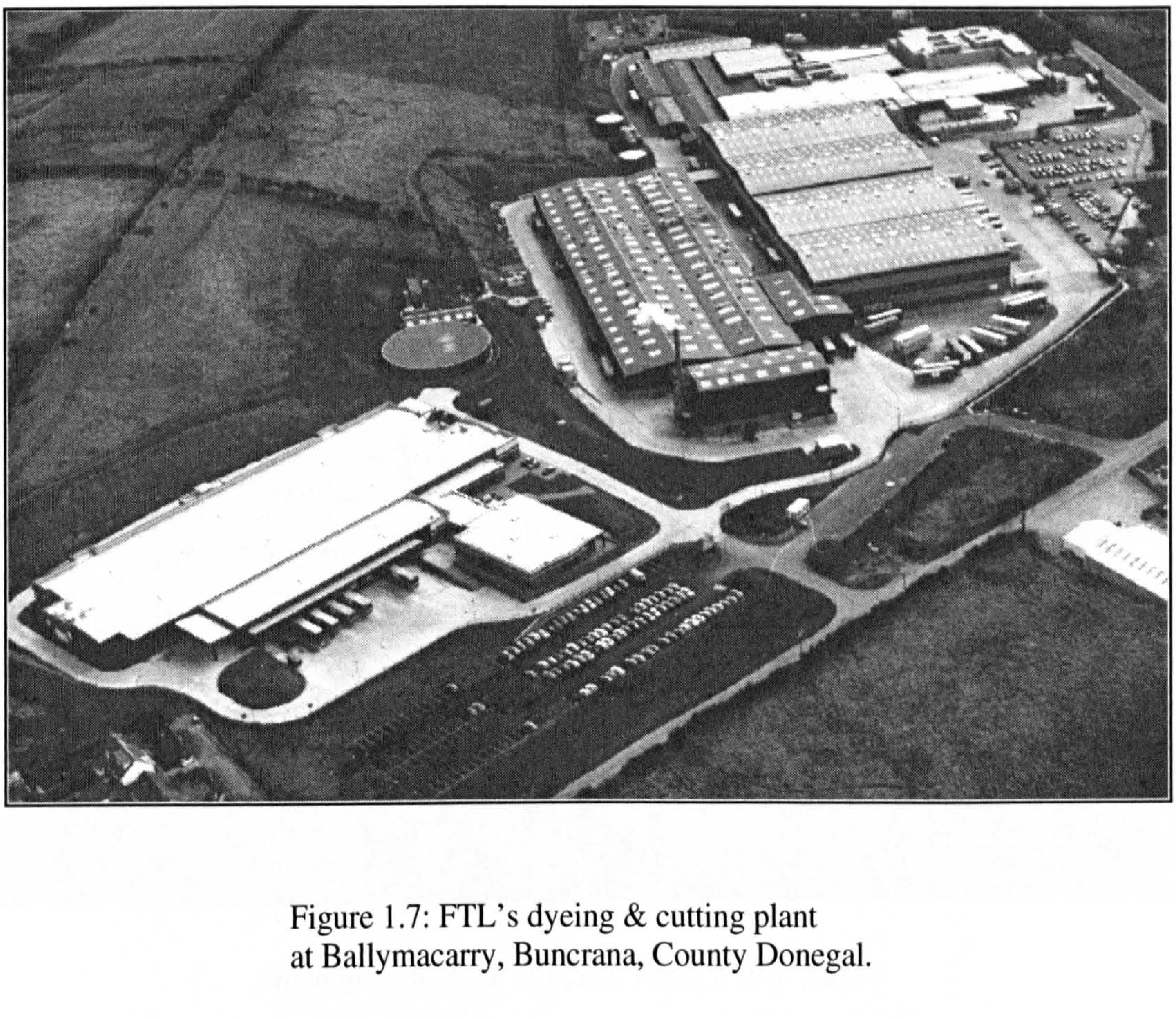


Figure 1.7: FTL's dyeing & cutting plant
at Ballymacarry, Buncrana, County Donegal.

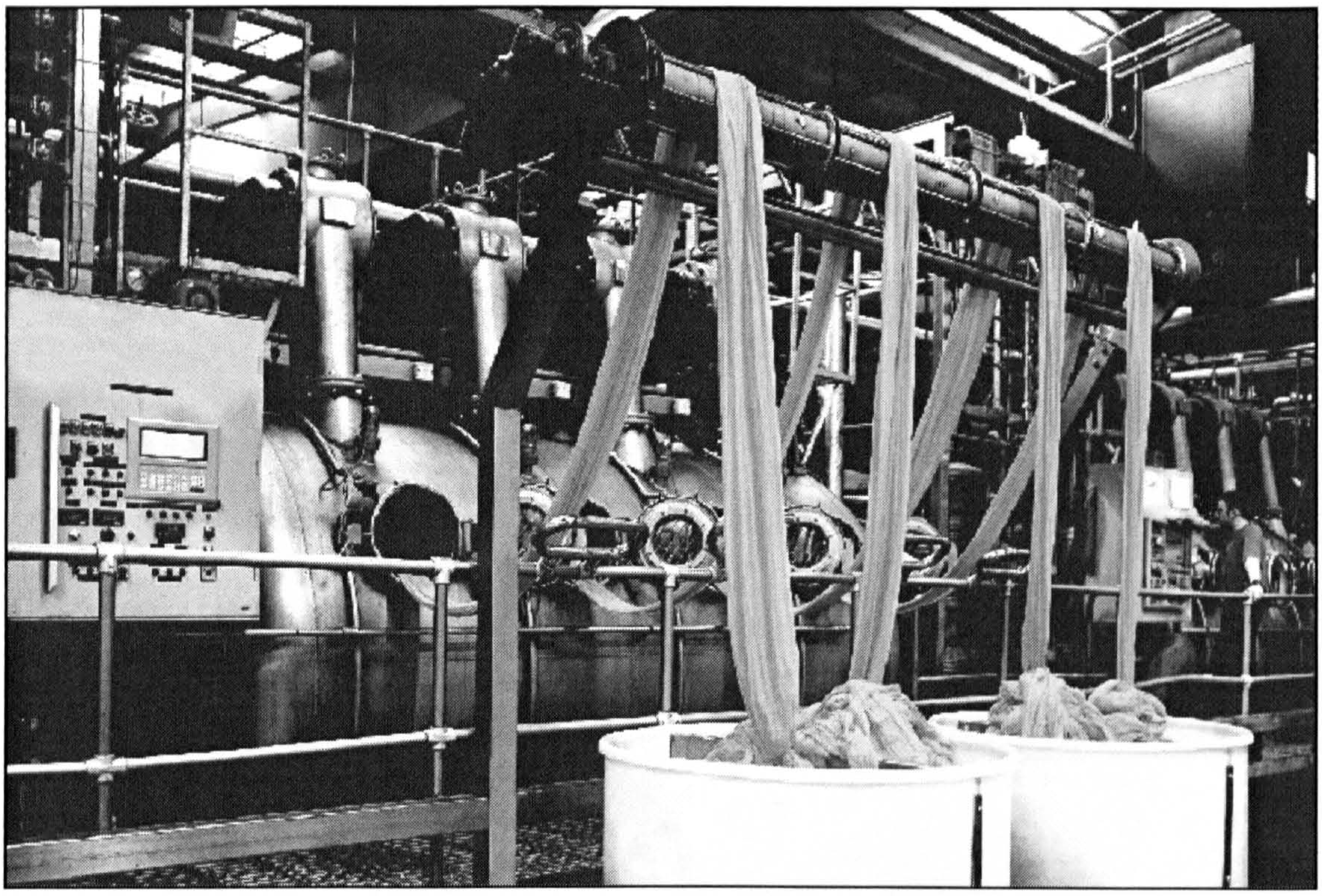


Figure 1.8: A dyeing machine unloading fabric.

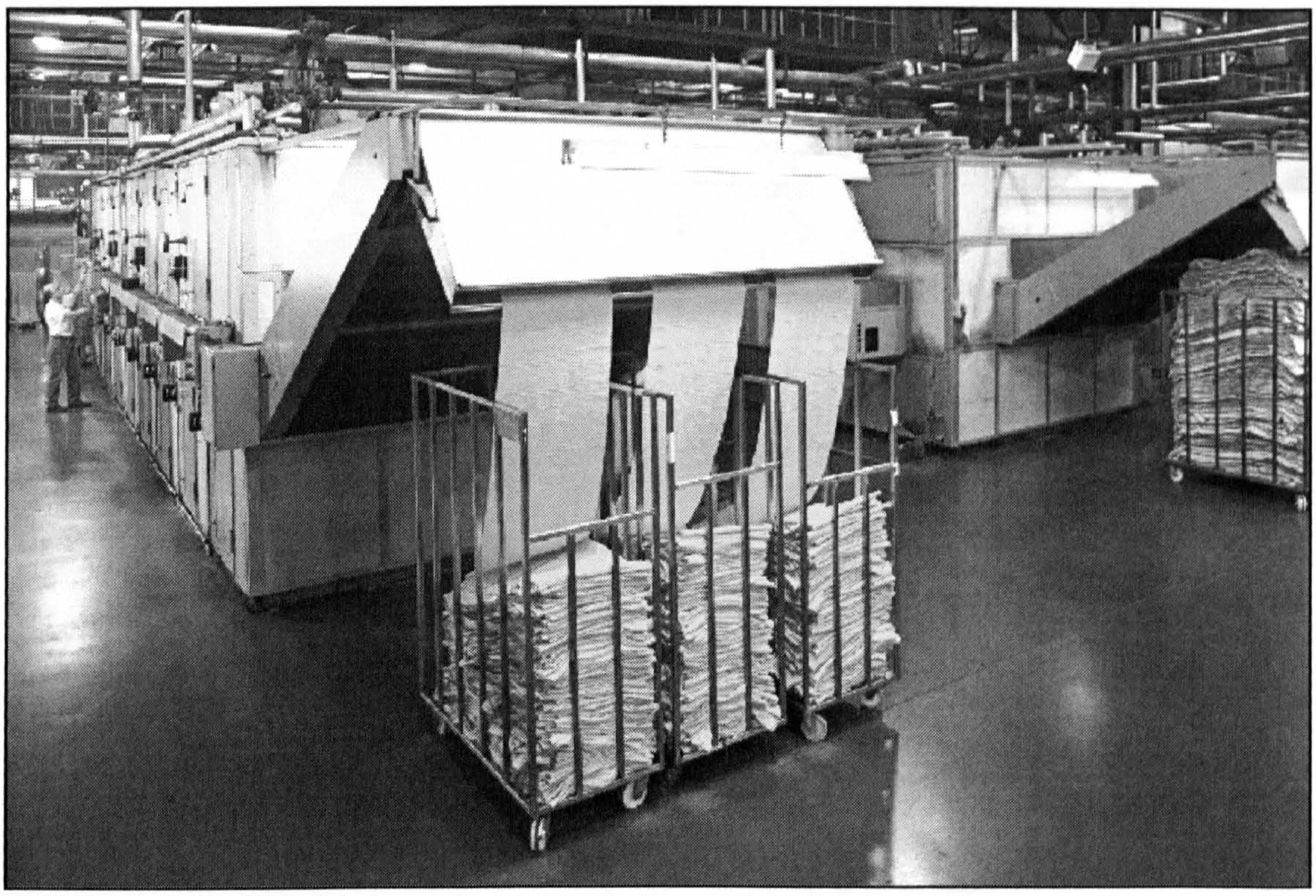


Figure 1.9: A dryer machine in the dyeing plant.

The coloured fabric is transferred to a cutting plant where the fabric is cut into the component parts of the products, again using highly automated technology (Figure 1.10), before being assembled into batches or lots for shipping to the garment assembly plants in Morocco. Here, teams of operators using industrial sewing machines assemble the garments. (Figure 1.11).

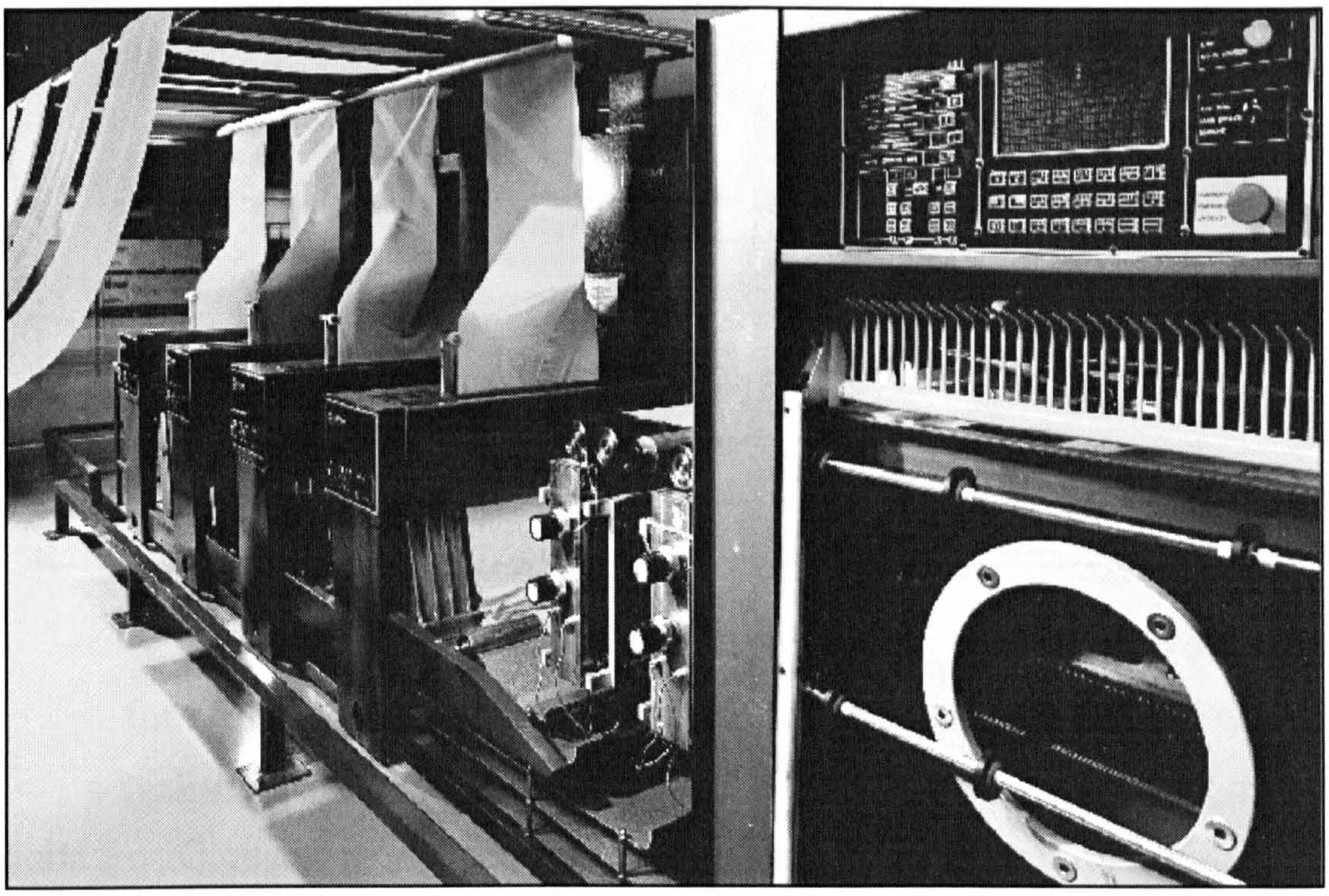


Figure 1.10: A cutting machine, where the continuous length of fabric is cut into garment parts.

Figure 1.11: Garment assembly operation, showing an operator sewing garment parts together (in Morocco).

The finished product is then transported to one of three major Distribution Centres in Europe (Germany, England and Spain), before being shipped to customers.

The operations in Northern Ireland and the Republic of Ireland employ approximately 850 people, and a further 1,800 people are employed in Morocco. 1.5 million garments are produced each week in Europe, and the emphasis is on high volume, low cost manufacturing.

1.2 An Outline of the Research

The research covered a number of key aspects of Manufacturing Technology Acquisition. At its simplest, the challenge was to find a better way of carrying out MTA than the methods currently employed by the Company, and to improve the success rates. The methods employed traditionally by the Company in selecting projects were based primarily on financial measures, for example, Payback Period and Return on Investment. The key components of the research included:

(1.) An examination of the literature on MTA and related fields.

(2.) An enquiry into some other manufacturing companies' experiences in carrying out MTA projects (external to Fruit of the Loom).

(3.) The adaptation and testing of selected techniques from the New Product Development field to MTA Project Selection and Management in Fruit of the Loom. This included monitoring the use of the adapted methods for actually running the Company's MTA programmes over three annual budgetary cycles.

(4.) A detailed review of a Single MTA Project in Fruit of the Loom to investigate how well these methods apply at a single project level.

These topics are covered in more detail in their respective chapters in this thesis.

1.2.1 The Research Objectives

The research objectives were driven from the initial research questions, and were refined after the initial literature review as being:

(1.) To identify a list of "factors" which might contribute to success or failure when acquiring manufacturing technology.

(2.) To identify a list of "measures" that can be used to determine the success or otherwise of manufacturing technology acquisition projects.

(3.) To develop a recommended complete method for the selection and execution of MTA projects in the Company.

Although the third objective is specific to the research sponsor's requirements, it was hoped that any new method or model for MTA derived from the research may have the potential for practical application in manufacturing companies in general. These research objectives were agreed with senior management in the Company at the outset of the research.

The research question could be phrased in many ways, but in a simple form it could read:

How to select the right projects and having chosen them, how to make them successful.

1.2.2 The Research Methodology

There are relatively few examples of comprehensive research studies on Manufacturing Technology Acquisition. There are even fewer practical examples of where the research work has been adopted by companies. By way of contrast, in the field of NPD, methods for successfully selecting and carrying NPD projects are now well established and accepted, for example, Cooper's (1993) "stage-gate" method. The absence of any significant body of research work in the field of MTA dictated the approach taken to this work.

Some elements of the research were exploratory. Others required an evaluation of the application of the techniques adapted from NPD practice. Several research methods were used. A comprehensive explanation of each is contained in chapter three.

Research to identify possible factors, which might contribute to success or failure in MTA projects, was undertaken by surveying managers outside of the Company. This was necessary and advisable so as not to limit the chances of arriving at a comprehensive list of factors and measures. This approach, examining the issues in MTA outside of the Company at first, followed by a more detailed internal focus in Fruit of the Loom was supported by the researcher’s Ph.D. Review Panel during a discussion on research design and methodologies at the student’s first review.

1.2.3 The Research Roadmap

The research plan comprised of a number of phases, elements and outputs, as shown in Table 1.1, below:

Phases	Elements	Outputs	Chapters
1. Research Project Definition	1. Initial Literature Review 2. Research Design & Methodology	1. Research Objectives 2. Research Methods to be used 3. Research Plan	One Two Three
2. Factors & Measures in MTA	3. Semi-structured interviews 4. Interview transcripts 5. Content Analysis 6. Additional Literature Review (+ new publications)	4. List of Success Factors 5. List of Success Measures 6. Checklist	Four
3. Traditional Project Selection methods; Adaptation of new techniques from NPD field using case study.	7. Detailed Literature review of methods 8. Evaluation Research on the adaptation of NPD techniques and test over three annual MTA cycles	7. Portfolio Management for MTA 8. New project selection method - Expected Manufacturing Benefit Concept 9. Test before Replication Concept	Five Six
4. Review of a single project from start to finish	9. Qualitative & Quantitative Research on Single Case in Company 10. Interviews 11. Machine Data 12. Standard Project Documentation.	10. Validation of Factors and Measures List 11. New issue – Strategic Change Impact	Seven
5. Impact of Strategic Change	13. Examination of corporate & divisional strategic change on MTA activities.	12. Appreciation of the impact of Strategic events on MTA activities	Eight
6. Research Discussion	14. Discussion & interpretation of results	13. A New Model for Manufacturing Technology Acquisition (MTA).	Nine

Table 1.1: The Research Plan

1.2.4 A Comparison of the Research Plan with a typical Technology Acquisition Model, to frame the scope of the research

Falguni & Rubenstein (1990) presented a ten-stage process for acquiring technology from outside, derived from a review of previous studies on the technology acquisition process. The focus of their journal article is on the integration of in-house R&D to this process, and not on the process itself. However, it provides a useful linear process model against which to frame this MTA research project (Figure 1.12).

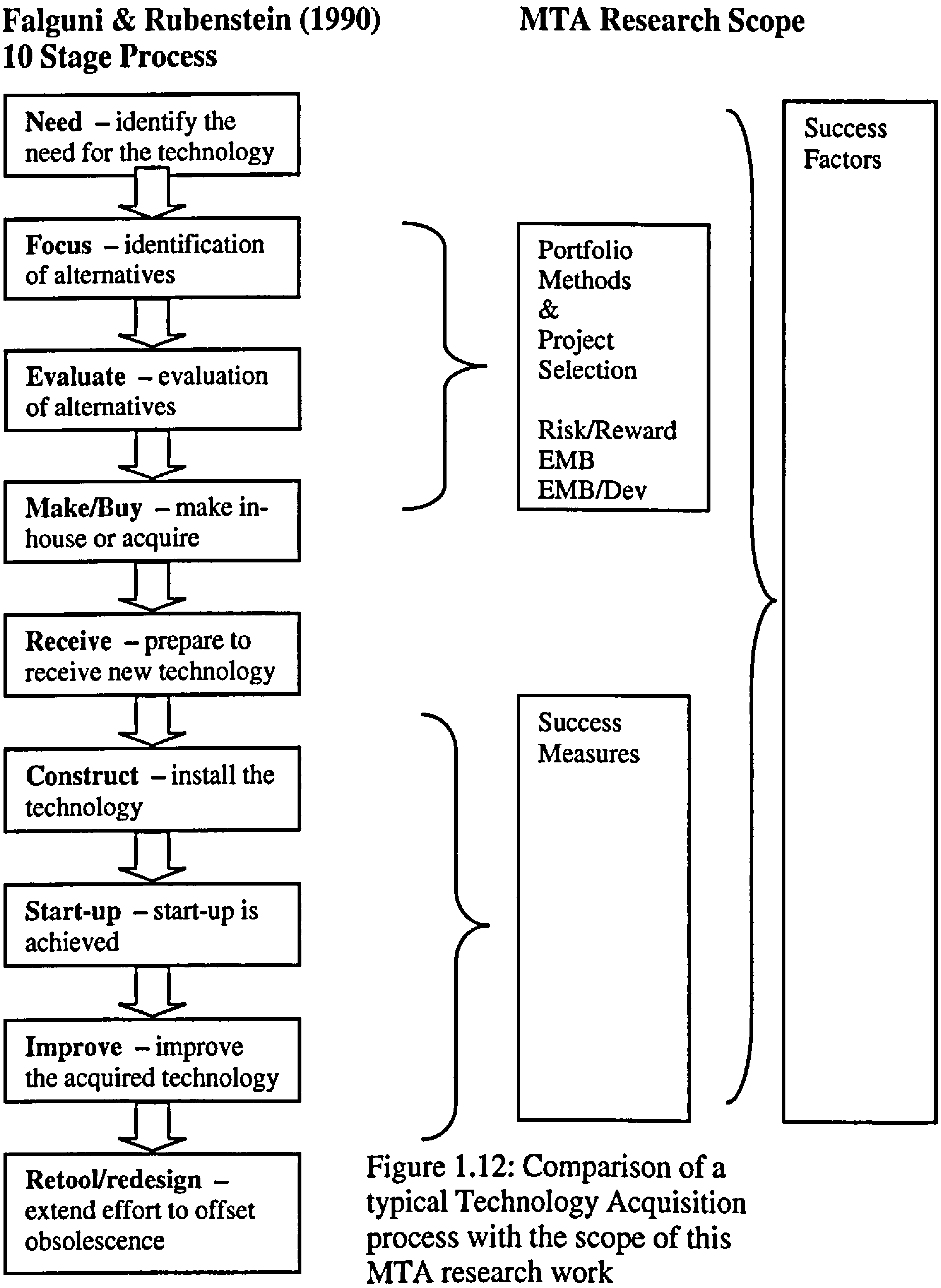


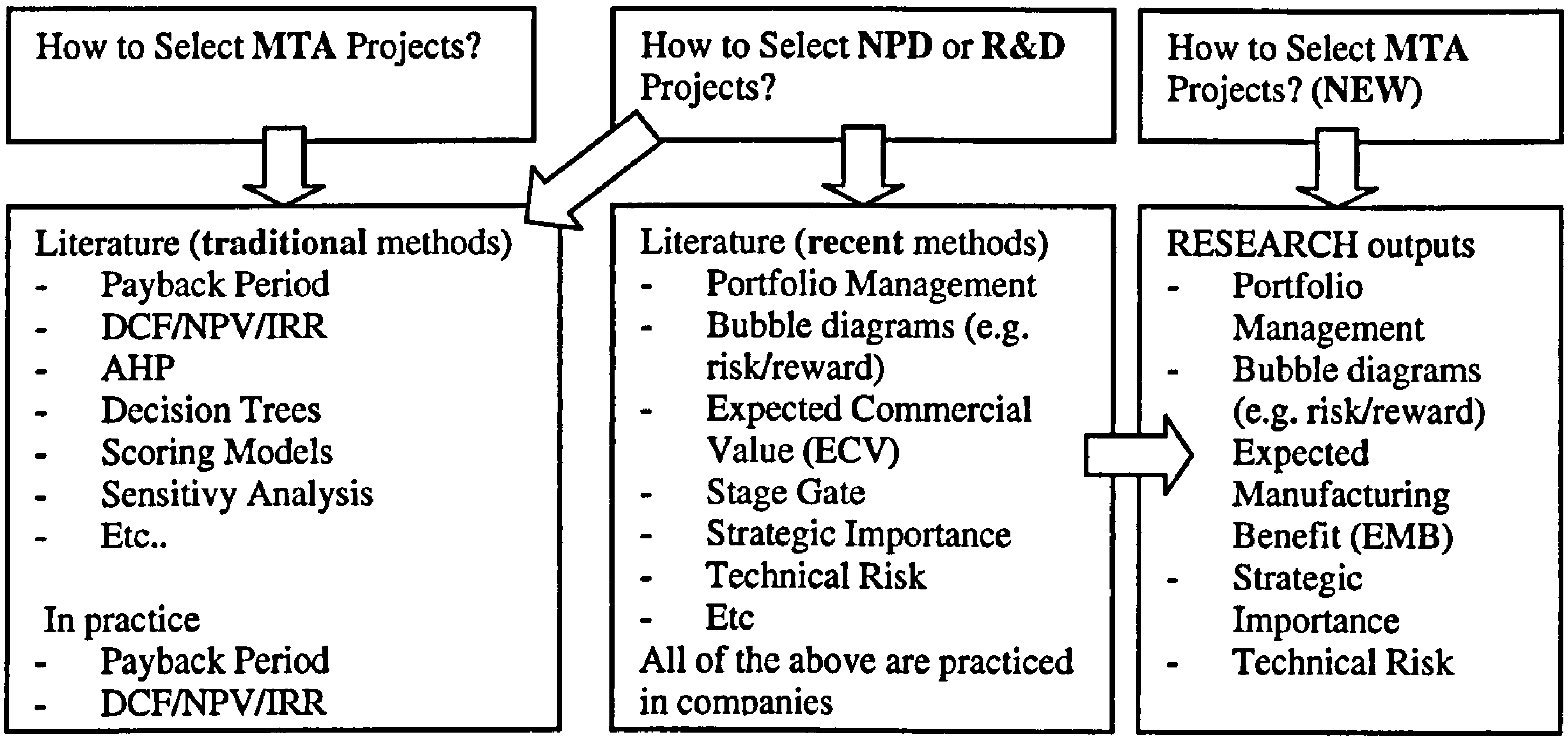
Figure 1.12: Comparison of a typical Technology Acquisition process with the scope of this MTA research work

The typical technology acquisition process is viewed by Falguni & Rubenstein (1990) and others as a sequential one, whereas in reality there will be iterations and reconsiderations throughout the project cycle. More importantly, known process models apply to a single project and do not address the challenge of the total portfolio of projects i.e. selecting the project population in the first place.

1.2.5 Bounding the Research Topic

Going back to the research objectives, Figure 1.13 shows the contextual boundaries of the research topic in relation to the research components.

(1.) How to select the correct MTA projects?



(2.) How to make a selected MTA project successful?

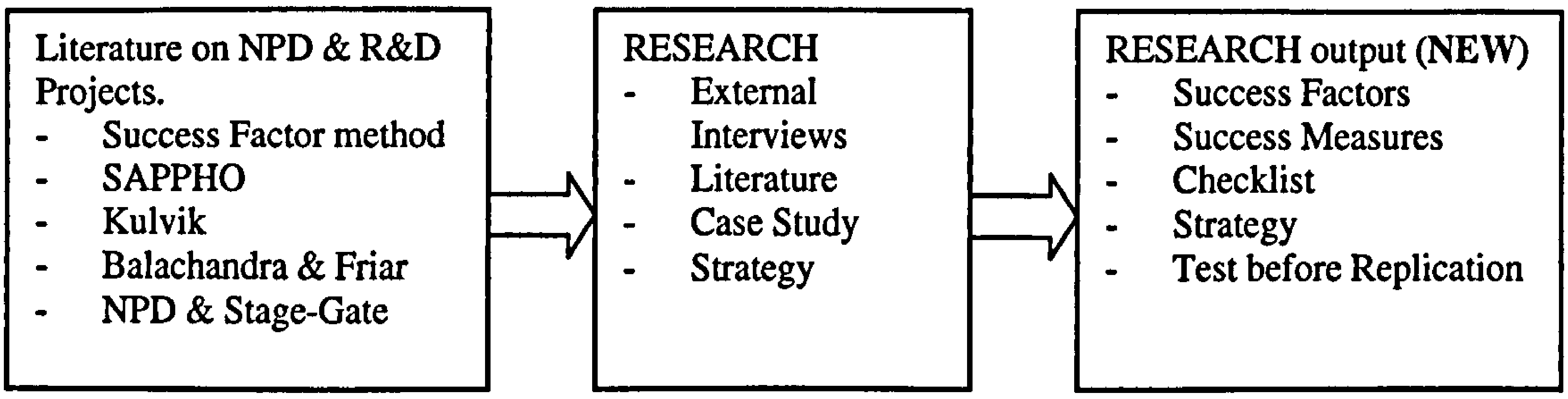


Figure 1.13: Contextual boundaries of the research project.

1.3 Management of the Research

The Research Project was carried out on a part-time basis during the period October 1995 to August 2002, just less than seven years in total. The research period allowed by the regulations of the School of Mechanical Engineering (SME) at the time of starting the research was five years minimum to eight years maximum for part-time research. The research progress was subject to five formal review meetings during the period of registration. The Ph.D. Review Panel members were:

- Professor Keith Goffin (Professor of Innovation Management, School of Management)
- Professor Barrie Moss (Professor of Thermofluids and Combustion, Head of Department of Aerodynamics and Thermofluids Engineering, School of Engineering)

The researcher submitted regular reports and travelled to Cranfield periodically for review meetings with his supervisor. Joint reviews with senior management in the sponsoring Company, the Supervisor and the student took place on a number of occasions at the Company's manufacturing facilities.

The researcher also discussed the research project at length and sought advice from the following academics in the Technology Management field:

- Professor Tom Allen (Professor of Management, Sloan School of Management, Massachusetts Institute of Technology)
- Professor Eric Beatty, OBE, (Former Head of N.I. Technology Centre, Queen's University, Belfast)

The research plan shown in Table 1.1 proved extremely useful in helping with adherence to the research schedule and timeline. One unforeseen delay in the project was caused by not realising how long it would take to produce interview transcripts, despite the advice in the research methodology literature. For example, the interview transcripts from the single case study in chapter seven alone contained approximately 34,000 words. Another unforeseen event was the appointment of the researcher to the position of director within the Company in October 1998, which resulted in a significant increase in demands on the researcher's time, and resulted in a six months lull in the research work.

1.4 The Intended Contribution of the Research

The intention of this study was to contribute to knowledge in the field of Manufacturing Technology Acquisition. From a practitioner standpoint, the researcher had direct responsibility for acquiring manufacturing technology. He had been working in the field of manufacturing technology acquisition for ten years in a number of companies prior to starting the research in 1995 and found the guidance in the literature to be of limited practical value in a real manufacturing setting.

The contribution of the research is comprised of a number of component parts:

(1.) It evaluates recent but well established concepts adapted from the fields of R&D Management and New Product Development to that of Manufacturing Technology Acquisition. It tests these techniques out in a "live" manufacturing environment over three annual cycles of technology acquisition and adapts them to address weaknesses found in their application in this new field. The Company, as official policy, adopted this new process as the means by which it acquires manufacturing technology.

(2.) An extensive checklist of factors that may contribute to success or failure when acquiring manufacturing technology is developed. Similarly a comprehensive checklist of measures, which can be used to determine whether or not a project has succeeded or failed, is presented.

(3.) It offers a unique insight into what can go right and what can go wrong during an MTA project by examining a single case in depth. This yielded additional insights into the critical impact that strategy, specifically strategic change, can have on MTA.

(4.) Finally, a new model for Manufacturing Technology Acquisition is presented, encompassing all of the above research findings and elements.

1.5 The Structure of the Thesis

This thesis is divided into nine chapters. Chapter two gives a comprehensive review of the literature, with particular emphasis on the initial literature review carried out in 1995 and 1996. This initial literature review contains a quantitative assessment of the publications reviewed in respect of their relevance to MTA. A more detailed review of sections of the literature is contained in subsequent chapters, where it was felt that the literature could be easier related to the topics being discussed in individual chapters. Chapter three explains the research design, the methodologies used and explains why certain methods were chosen.

Chapter four includes a review of the literature on the success factor method and reports on the external survey of other manufacturing managers' or technology managers' experiences of MTA, to derive the list of success factors and measures.

Chapter five examines the area of project selection and introduces the concept of portfolio management within R&D and new product development. Chapter six extends these concepts further by taking selected techniques from the literature, adapting and applying them in an evaluation study using the case method in a real manufacturing environment over three annual cycles.

Chapter seven reports the case study on a single MTA project. It validates the earlier research work on factors and measures and gives new insights into what can happen during a single MTA project, particularly in relation to the impact of strategy on project level events. Chapter eight leads on from this strategy theme in that it gives an overview of the changes in the Company's strategy during the period of the research project and examines the impact on MTA activity.

Finally, chapter nine takes the combined findings and results of the research, presents them in the form of a new, practical model for MTA. It reviews the research questions asked, the extent to which the research achieved the stated research objectives and provides guidelines as to how the research can be applied in a manufacturing environment. Limitations of the work are discussed and suggestions are made for further research. Then, general conclusions on the research are given.

1.6 Summary

This chapter has laid out the structure of the research project, the methods used and scope of the thesis. The research described herein is aimed at delivering an improved methodology for undertaking Manufacturing Technology Acquisition in firms.

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Chapter 2

Literature Review.

2.0 Introduction

This chapter reviews literature in the area of Manufacturing Technology Acquisition and related fields. The initial literature review was undertaken over a one-year period starting in October 1995. This chapter contains the following components:

(1.) The initial literature review & method of review
(2.) The categorisation of papers for a research database
(3.) An analysis of the literature
(4.) A review of the highly rated articles
(5.) Recent Literature
(6.) Books
(7.) Discussion

A more detailed review of certain sections of the literature is contained in later chapters as it was decided that they could be more readily discussed and contrasted with the research findings within the relevant chapters.

2.1 The Initial Literature Review

The original field of interest was defined as the acquisition of manufacturing technology, with particular emphasis placed on manufacturing process development. However, in order to ensure that no relevant articles were overlooked, an initial broad-based search was undertaken which also covered related fields including:

- Research & Development
- New Product Development
- Strategic Management
- Technology Management
- Production & Operations Management
- Manufacturing
- Engineering

2.2 The Literature Review Method

A structured approach to the literature review was undertaken, starting with an initial broad-based review of the literature using selected key words on the library computer catalogue, Libertas. This was followed by a review of the literature using selected key words (Appendix B (i)) on BIDS and abstracts' databases (ABI/ Inform, Compendex). Next, key authors and key journals in the field were identified, followed by a second search of the databases by both journal and author. A review of the grey literature (conference proceedings, for example, the Institute of Mechanical Engineers) was undertaken at this time.

The next step was to take the abstracts, approximately 1,200 in total, from the central library databases and download them to a floppy disk before inputting them to Microsoft Word. Each abstract was then systematically reviewed for its relevance to the field of interest. If an abstract was determined to be relevant, its reference was entered into a Microsoft Access database developed by the researcher (Appendix B (ii) CD ROM) for recording and analysing the literature. The researcher developed descriptions and a rating scale for quantitatively assessing the relevance of each article to the research topic (Figure 2.3). The initial filtering process resulted in the number of articles entered to the database being approximately 500, compared to the original 1,200 abstracts reviewed. Samples of the journal papers were then obtained to test the accuracy of the initial ratings. The ratings were determined to be accurate.

A physical search of the journals was also conducted. A copy of each of the higher rated articles (rated 3 to 5) was obtained for review. As the articles were found to cover a broad range of topics within the research area, a system of categorisation was developed and each paper was coded against a specific category. For example, a paper on the strategic management of R&D was coded to the category “strategy”.

A further search was undertaken using Internet search engines. The key words already developed from earlier library database searches were again used in this search. Also, the researcher visited the university websites of key authors to obtain a complete listing of their publications, working papers and current research interests.

Each journal article was reviewed and a final rating of its relevance was input to the database. Next, the population of the database was analysed using simple quantitative techniques (for example, how many papers were given the maximum 5 rating?).

Books were reviewed simultaneously with papers, but a separate database for books was developed.

At the end of the initial literature review, the databases contained bibliographic details of over 500 journal articles and 27 books, each classified according to the area of technology management or research and development that they primarily addressed.

The database was added to throughout the research period, as new relevant papers were published, and it now contains approximately 600 journal references and 40 book listings.

2.2.1 Article Categorisation & Analysis

Each journal article was classified into a sub-category of Technology Management or R&D Management. This made sorting and analysis by category possible, using the sort function within Microsoft Access. The categories used and a brief description of each is given in Table 2.1:

Category	**Database Descriptor**	**Description**
General	GEN	General articles on R&D and Technology Management
Global	GLOBAL	Global / international R&D and Technology Management
Historical	HIST	Historical reviews of R&D and Technology Management
Integration	INTEGRATION	Integration of R&D with other business functions
Manufacturing	MFT	Manufacturing, Production, Engineering
Organisation	ORG	Organisation issues including structure, finance, training, etc
Process Development	PROCDEV	Manufacturing Process development and improvement
Product Development	PRODEV	Product development, new products, product innovation
Productivity	PRODUCTIVITY	R&D productivity, performance, measurement
Project	PROJECT	Project selection, evaluation, control, planning, management
Specialised	SPEC	Industry specific analysis, case studies
Strategy	STRATEGY	Strategy, tactics, competitiveness
Technology Acquisition	TECH ACQ	Make or buy, internal & external acquisition, implementation
Technology Transfer	TECHTRAN	External only, linkages, supply, diffusion, adoption, gatekeepers

Table 2.1: Categories into which each of the journal articles were assigned to assist with further analysis and review.

It proved possible to classify all the selected articles into one of these categories. The reason for creating this classification system was to examine which areas of R&D and technology management have been researched extensively, and which areas have possibly been under-represented in the literature.

2.2.2 Results of Category Analysis

Table 2.2 below summarises the findings from the category analysis:

Category	**Number of Articles**	**% of Total**
General	41	8.2%
Global	57	11.4%
Historical	6	1.2%
Integration	17	3.4%
Manufacturing & Engineering	51	20.2%
Organisation	72	14.4%
Process Development	**9**	**1.8%**
Product Development	65	13.0%
Productivity	18	3.6%
Project	42	8.4%
Specialised	20	4.0%
Strategy	63	12.6%
Technology Acquisition	**12**	**2.4%**
Technology Transfer	27	5.4%
Total	500	100%

Table 2.2: Percentage of Articles by Category. Those categories highlighted in bold are specific to the research area of MTA.

From this analysis it is clear that the research area of this thesis, the acquisition of technology for manufacturing, represents only a small proportion of the available literature. Articles on manufacturing process development and technology acquisition account for only 1.8% and 2.4% respectively, of the total literature entered into the database.

2.2.3 Article Rating Scale & Analysis

A rating scale was devised to assist with the assessment of each article's relevance to the present research. The scale is from 1 to 5 and an explanation of the corresponding qualitative interpretation for each rating value is given in Table 2.3.

Rating	Description
1	Article has no relevance to field of interest whatsoever but has some reference to R&D or Technology Management
2	Article has no direct relevance to Manufacturing Technology Acquisition but has some reference to R&D or Technology Management
3	Article has some relevance to Manufacturing Technology Acquisition, though not directly. It may be useful to review article.
4	Article is directly relevant to Manufacturing Technology Acquisition. It may or may not contain a specific reference to manufacturing process development
5	Article is extremely relevant to Manufacturing Technology Acquisition and also deals specifically with manufacturing process development

Table 2.3: Article Rating Scale & Descriptions

The outcome of the ratings analysis for the field of interest is shown in Table 2.4 below:

Rating	1	2	3	4	5
Number of Articles	110	155	152	73	10
% of Articles	22.0%	31.0%	30.4%	14.6%	2.0%

Table 2.4: Analysis of Article Relevance to
Process Development or Technology Acquisition.

Only 2.0% of the articles (i.e. ten articles) on Technology Management were determined to be of a high degree of relevance in relation to the research area. Of these ten articles rated '5', nine were published after 1990, the exception being an article on Technology Transfer in 1980. This indicates that research efforts have only recently begun to focus on manufacturing technology development.

Of the nine articles categorised as Process Development, all were published from 1991 onwards. Similarly, ten out of the twelve papers on Technology Acquisition have been published since 1990. In contrast, 40% of the Strategy papers were published before 1990, as were 50% of the Project papers. A review of the highly rated articles follows in a later section of this chapter.

The above analysis covered journal articles only. Books on R&D and technology management were not amenable to such analysis because each book covers a range of topics unlike a journal article.

2.2.4 Journals Reviewed and Total Number of Articles per Journal.

Table 2.5 shows a listing of the journals reviewed, the number of selected articles per journal and the percentage this represents overall of the total articles reviewed during the initial literature review.

Journal	No.	%
R&D Management	155	27.9%
Research Policy	72	12.9%
IEEE Transactions on Engineering Management	69	12.4%
Research-Technology Management	47	8.5%
Harvard Business Review	27	4.9%
Journal of Product Innovation Management	23	4.1%
Long Range Planning	17	3.1%
Technology Analysis & Strategic Management	17	3.1%
Journal of Engineering and Technology Management	10	1.8%
Sloan Management Review	10	1.8%
Journal of Business Strategy	8	1.4%
California Management Review	7	1.3%
Engineering Management Journal	7	1.3%
Technovation	7	1.3%
International Journal of Technology Management	6	1.1%
Management Science	6	1.1%
Project Management Journal	4	0.7%
Research Management	4	0.7%
Administrative Science Quarterly	3	0.5%
IEEE Engineering Management Review	3	0.5%
Brookings Papers on Economic Activity	2	0.4%
Business Horizons	2	0.4%
Business Quarterly	2	0.4%
International Marketing Review	2	0.4%
Journal of Management Studies	2	0.4%
Organizational Dynamics	2	0.4%
Strategic Management Journal	2	0.4%
Technological Forecasting and Social Change	2	0.4%
Across the Board	1	0.2%
American Economic Review	1	0.2%
Business History Review	1	0.2%
Computers & Industrial Engineering	1	0.2%
Decision Sciences	1	0.2%
Economic Journal	1	0.2%
Engineering Management International	1	0.2%
ICL Technical Journal 7	1	0.2%
IEEE Spectrum	1	0.2%
IMech E Part B : Journal of Engineering Manufacturing	1	0.2%
Industrial Management and Data Systems	1	0.2%
Industrial Engineering	1	0.2%
Industrial Management	1	0.2%
Industrial Marketing Management	1	0.2%
Industrial Marketing Management (IMM)	1	0.2%
International Journal of Human Factors in Manufacturing Technology	1	0.2%
International Journal of Management Science	1	0.2%
International Journal of Operations & Production Management	1	0.2%
International Journal of Production Economics	1	0.2%
International Studies of Management & Organisation	1	0.2%
Journal of Economic Behaviour & Organisation	1	0.2%
Journal of Economic Literature (JEL)	1	0.2%

Journal of Management in Engineering	1	0.2%
Journal of Small Business Management	1	0.2%
Les Nouvelles	1	0.2%
Managerial & Decision Economics	1	0.2%
Manufacturing Engineer	1	0.2%
Omega	1	0.2%
Organization Science	1	0.2%
Planning Review	1	0.2%
Proc.Tech.Transfer.Soc meet	1	0.2%
Production and Operations Management	1	0.2%
Research Journal	1	0.2%
Review of Economics & Statistics	1	0.2%
Technische Mitteilungen Krupp	1	0.2%
Technology Forecasting and Social Change	1	0.2%
Technology Review	1	0.2%
The McKinsey Quarterly	1	0.2%
Total	556	100.0%

Table 2.5: Articles per Journal

There is a concentration of articles across a small number of journals, with 427 of the total papers reviewed (77%) contained in eight journal titles. The remaining 129 papers (23%) are spread across a further fifty-eight journal titles.

The articles rated '5' were found mainly in the following journals:

- IEEE Transactions on Engineering Management
- Journal of Engineering and Technology Management
- R&D Management
- Technovation
- Research Policy

These findings correspond with a citation analysis of the technology innovation management journals reported by Cheng *et al* (1999).

2.3 A Review of the highly rated Articles

The term Technology Acquisition is used in the literature to cover a spectrum of activities ranging from internal development to wholly external acquisition of technologies. The following reviews are representative of the literature on technology acquisition and are taken from those papers given a 4 and 5 rating from the analysis of the literature.

Falguni and Rubenstein (1990) argue that the role of in-house R&D is changing and that more and more firms are involving their R&D resources in the external technology acquisition process. The new role for in-house R&D appears to be one of integrating its strategy with the overall technology strategy of the firm. The authors propose ten distinct phases in the process of acquiring and implementing external technology:

(1.) Stage 1 - **Need**: there are a number of activities related to developing an awareness of the need for a new technology

(2.) Stage 2 - **Focus**: this awareness gets better focused, which results in the identification of alternatives and an enumeration of criteria which will be used to evaluate these alternatives

(3.) Stage 3 – **Evaluate**: the actual evaluation of alternatives takes place

(4.) Stage 4 - **Make/buy**: a decision is taken to make the technology in-house or to acquire it externally

(5.) Stage 5 - **Negotiate**: the negotiations for technology acquisition take place. This completes the acquisition phase of the process. The implementation phase begins next.

(6.) Stage 6 - **Receive**: where the firms prepare to receive the new technology

(7.) Stage 7 - **Construct**: the technology is installed

(8.) Stage 8 - **Start-up**: the technology is first made to work

(9.) Stage 9 – **Improve**: improvements are made to the acquired technology

(10.) Stage 10 - **Retool/redesign**: effort is expended to ensure that the acquired technology does not become obsolete.

Falguni and Rubenstein give various levels of recommended involvement by R&D in each of the phases.

A study of firms in Sweden, Japan and the United States by Granstrand *et al*, (1992) revealed that the external acquisition of technology was the most prominent technology management issue in large multi-tech corporations. The authors offer a useful typology of strategies for acquisition and exploitation of technology. The technology base of a company is viewed as an asset that represents the technological capability that the company possesses. The authors point out, however, that strategies for technology acquisition require integration with in-house R&D. Internal R&D is viewed as the most integrated technology acquisition strategy, with Technology Scanning as the least integrated strategy.

Much of the literature on Technology Acquisition deals solely with external acquisition. Cutler (1991) lists three main challenges in relation to external acquisition; where to find it, how to find it, and how to transfer it. He does not deal specifically with the implementation phase. When the literature deals only with the acquisition of technology from outside of the firm, it is often termed 'Technology Transfer'. When the term 'Acquisition' is used, it implies that internal R&D remains an option as a means of acquiring the technology.

Of the nine papers classified as manufacturing process development, four originate from the same author, Marcie Tyre, formerly Associate Professor of Management at MIT. A further two of the nine are papers by Gary Pisano, Harvard Business School.

Tyre (1991) examines the introduction of new technologies in the manufacturing environment. She reported mounting evidence that companies were failing to implement and exploit new process technologies effectively.

Thurow (1987) blames America's poor productivity, quality and trade performance on inferior capabilities in introducing and using process technology.

Much of the existing research on process innovation and diffusion has focused on the decision to adopt new technology, rather than on the process of learning to effectively use the technology once it has been brought into the organisation. Further, existing research on "implementation" issues focuses primarily on developing organisational attitudes and receptivity to change (Rogers, 1982).

Tyre (1991) argues that the introduction of new process technologies often involve considerable problem solving and innovation at the manufacturing plant level. Tyre (1991) states that:

> *"U.S. companies still have not learned how to introduce and exploit advanced production technologies to become competitive in global markets. Manufacturing managers often buy the most advanced equipment and systems but then fail to integrate them fully into production."*

She identified three related areas of managerial choice that affect the ability of firms to successfully introduce new processes technologies. Firstly, the style of managerial decision-making for investment in process technology: does a coherent strategy for process development exist? The second area relates to practices and relationships that govern existing manufacturing processes: what level of outside supplier involvement is standard during the implementation? Finally, the systems for building technical competencies in the organisation impact on the success probability. This research explicitly links the ability to introduce and effectively utilise new process technologies to existing organisational practices and past investments in technical capabilities.

Pisano and Wheelwright (1995) report that Manufacturing process innovation is becoming an increasingly critical capability and companies should devote more resources and attention to process R&D. Their research in the pharmaceutical industry has shown that traditionally senior managers believe that process technology has been viewed as being not very important. However, they argue that a focus on process development can not only significantly reduce manufacturing costs, but can also accelerate time-to-market, yield rapid production ramp-up, enhance product functionality and extend the proprietary position of their products. The authors argue that companies will have to create new strategies, approaches, and organisational capabilities to enable the full contribution of process development to be attained.

Bohn (1994) approaches process development from the viewpoint of technological knowledge. A framework for mapping and evaluating levels of technological knowledge is developed. This framework is then applied to measure how much an organisation knows and does not know about its production processes, to learn where knowledge resides in a company, and to make better use of what is known. Eight stages of technological knowledge are determined, ranging from complete ignorance to complete understanding. In order to manage and develop manufacturing processes, all the variables governing the process have to be identified. Even a single manufacturing process has many variables and sub-variables that are inevitably at different stages of knowledge. As more is learned about part of the process, old variables are brought to higher stages, but new variables also emerge from the mists of ignorance. The determination, measurement and understanding of these variables are the means by which process improvement can be mastered.

The fundamental challenge of process development is quite similar across industries despite differences in specific activities (Pisano, 1994). The starting point for process development is a description of the product. In chemicals, this might be a written description of the molecule, a formula for the required set of reactions, and other data characterising the molecule. Product designs normally also include a set of functional specifications as targets. At the time process development starts, of course, the description may well be incomplete or in a state of flux. This is quite often the case when a new product and process are involved as opposed to further development of an existing process. While a well-specified product design might allow a sufficiently skilled person to build a replica of the product, it does not include a specific set of instructions for making large quantities. Pisano argues that this is where process development fills the gap between concept and manufacture.

The output of process development is an organisational routine for production. The organisational routines for manufacturing processes may include technical specifications (such as equipment designs, process conditions, and raw materials) and a complete set of standard operating procedures for use by operators or computers which monitor and control the process. Process development creates the organisational routines needed to replicate knowledge embedded in a product design. At the core of this is the ability of a firm to acquire and successfully implement manufacturing technology.

Cross-functional integration between R&D and manufacturing is a particularly important issue in process development and MTA. Since process performance is affected by interactions between technical choices (e.g., a machine cycle time) and the actual operation conditions and capabilities of the manufacturing site (e.g., how the plant's equipment is acquired, operated and maintained), technical choices must be tightly integrated with operating choices and conditions. Given these interaction effects, it makes little sense to describe a process technology in isolation from the actual operating environment. Pisano (1994) views process technology as a set of technical choices embedded in a set of operating routines.

The above description of the some of the highly rated journal articles is indicative of the topics covered in the literature. While they deal with specific issues associated with MTA, they do not really offer any definitive guidelines or whole process models as to how to go about it.

2.4 Reasons for Acquiring Technology

A report on the acquisition of technology for product and process innovation by EIRMA[1] (1992) listed six reasons for acquiring technology:

- development of new products
- maintenance of competitiveness by improvement of product and processes
- cost reduction
- expansion of market share through a combination of some of the above elements
- compliance with regulations
- to meet quality standards and the needs of 'just-in-time' production philosophy

Technology plays a key role in achieving business success and a company will acquire technology for any or all of the above purposes.

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[1] EIRMA is the European Industrial Research Management Association, a body which constitutes a means for technology-based companies in Europe to cooperate with a view to achieving increased productivity and effectiveness of industrial research and development. It is comprised of 170 companies in 18 different countries and was established in 1966.

2.5 Strategies for Acquiring Technology

The EIRMA Report (1992) on technology acquisition also gives a number of approaches open to companies that need to acquire new technologies:

- internal development
- sponsored external development
- outright purchase from an external source
- licence agreement with an external source
- technology interchange with an organisation with complimentary technologies and needs
- joint venture with another company to develop the technology
- formation of a strategic alliance with another company
- participation in pre-competitive collaborative research programmes

All of the above options are open to any industrial organisation with an internal development capacity. The chosen option will depend on many factors including the maturity of the product or process involved.

2.6 An Update on the Literature

The original literature review was carried out in 1995 and 1996. This section contains a review of selected journal articles published after the initial literature review had been completed.

Chung (1996) focused on the identification and analysis of human factor issues influencing the successful implementation of Advanced Manufacturing Technology (AMT). He surveyed 41 firms in Pennsylvania, U.S.A. that had recently implemented AMT. He reported six key findings:

(1.) The presence of a technological champion was significant throughout all phases of implementation. This finding reinforced the commonly held belief of the importance of top management support in AMT if AMT projects are to succeed. The individual must have sufficient knowledge to appear credible to workers, as well as to make informed decisions about the new equipment

(2.) The start-up period of AMT implementation is typically problem prone. Constant encouragement or lack of it by the champion can have a significant influence on the outcome of this stage

(3.) The hands-on experience of shopfloor workers was found to be statistically significant during the planning phase of implementation

(4.) The use of more capable workers in terms of skills, knowledge and attitudes was significant during the installation phase, but not the start-up phase

(5.) Pilot level installation and the use of higher skilled workers during installation significantly improves the chances of success

(6.) Worker empowerment should only take place after proven start-up phase. Encouraging worker empowerment with an unstable manufacturing system could have potentially negative results

Overall, Chung concludes that proper attention to the human issues is necessary during each phase of AMT implementation, but is not sufficient to guarantee overall success.

Balachandra and Friar (1997) developed a "contingency framework" in their study of factors for success in R&D projects and new product innovation. Their work is reviewed in more detail in chapter four of this thesis.

Lipovetsky *et al* (1997) carried out an investigation into the relative importance of project success dimensions based on a study of 110 defence projects performed by industry in Israel. They defined four dimensions of success in development projects:

(1.) Meeting design goals

(2.) Benefits to the customer

(3.) Benefits to the developing organisation

(4.) Benefits to the defence and national infrastructure

Within these four dimensions of success, they developed 20 measures of success. Although not directly related to Manufacturing Technology Acquisition, it proved useful to compare the success measures they established with those developed in the survey in chapter four.

Slowinski *et al* (2000) investigated how 22 companies acquired external technology by interviewing their external technology directors. Again the focus of the study was acquisition for NPD/ R&D and not MTA. The objective of their study was to identify commonality in how organisations identify, access, and evaluate external technology. They found that most companies did not have a structured/ organised technology acquisition effort. They reported seven key ingredients for success:

(1.) Understanding the company's technology needs: A strategic understanding of the current intellectual property portfolio and future technology needs is essential.

(2.) Identification of external technology: It is important to understand where to look for external technology in order to increase the likelihood of successful integration of the technology. For example, for pharmaceutical companies, cooperative research efforts with biotechnology firms had proven beneficial.

(3.) Evaluation and assessment of technology leads: Evaluate the technologies to identify the quality of the technology and the process by which it can be acquired.

(4.) Valuation of the technology: Determine the costs of bringing it into the existing business.

(5.) Developing a technology agreement: Have a well-planned process to identify potential obstacles when integrating the technology into the business.

(6.) Metrics for measuring success: The most successful technology acquisition projects were found to be those which benefited the monetary bottom line of the business.

(7.) A clearly defined technology acquisition process: The most successful projects were those that are completed in a timely manner and contribute rapidly to the finances of the company. A clearly defined process is required to ensure an effective acquisition.

While these findings were not directly related to MTA activities, they offer a useful framework against which to contrast the research findings of this thesis.

Brown (2001) reported on a study of managing product and process technology in the computing and automobile industries. He stated that:

> *"Managing process and product technology is a profoundly difficult and uncertain task. Learning and know-how must be accumulated over time in order for process technology to be applied successfully. Vast amounts of investment have taken place in firms and such investments have often provided little or no tangible benefits for the firm."*

In this study into Computer Integrated Manufacturing (CIM), he concluded that successful implementation of all forms of CIM is dependent to some degree upon the firm clearly understanding present and future market needs and investing in the appropriate automation to support these needs. In what he terms "enlightened" firms, he found that investment came in stages as part of their continued, but incremental, improvement programmes. Investment was made as an holistic decision, aided and enhanced by the role of manufacturing strategy, involving senior-level manufacturing personnel in understanding business requirements of the plant. Justification went beyond purely accounting criteria to a long-term commitment to satisfying customer requirements in ever changing markets. On the other hand, "traditional" plants saw technology as a quick but expensive solution once the financial justification had been made.

While Brown presents an interesting study into the differences between how firm's manage their process technology, he does not offer any structured or systematic methodology as to how to carry out this activity or how to manage MTA.

In keeping abreast of the literature during the entire research period, the researcher has not as yet found any substantial answers to the original research question of how to select the right MTA projects and having selected them, how to make them successful.

2.7 A Review of the Books

A large number of books have been published on the subject of Technology Management. In this section, the author reports briefly on some of the more important textbooks reviewed during the research. Many of the books on technology management take a holistic approach in their coverage of the subject, containing many varied topics within a single textbook, whereas others are focused on a single technology management issue. This review is presented mainly in chronological order.

Woodward (1965) was one of earliest authors to mention technology as a key strategic variable in an organisation. Technology strategy has only been covered as a subject in its own right from the mid-eighties. Burgleman and Madique (1988) propose that business strategy should be comprised of a number of functional strategies, one of which is a technology strategy. They argue that many technology-based firms do not have a formal technology strategy and that this is a major weakness.

Steele (1989) addressed technology management from a strategic perspective. He argues that the management of technology is actually the practice of integrating technology strategy with business strategy in the company. He states that this integration requires the deliberate coordination of the research, production, and service functions with the marketing, finance and human resource functions of the firm.

Noori and Radford (1990) presented a collection of readings and cases aimed at bringing a managerial perspective to new technology adoption and implementation. The book is mainly comprised of multiple case studies within organisations and relates their experiences of implementing new technologies. It offers useful guidelines on adopting new technology and lessons from within the case studies. It examines adoption primarily at the single project level and does not explicitly address selecting a portfolio of MTA projects.

Third Generation R&D-Managing the Link to Corporate Strategy (Roussel *et al*, 1991) offered new insights into how to manage R&D at a strategic level within organisations. They state that the issues that any firm must consider when deciding its technology strategy include selecting the projects and setting project goals, allocating resources among R&D efforts, balancing the R&D project portfolio, measuring results and evaluating progress. They advocate that the corporate, business and R&D functions must be integrated to develop a single action plan that serves the strategic purpose of the business.

Roussel *et al* state that R&D has three major strategic purposes:

(1.) To defend, support, and expand existing business
(2.) To drive new business
(3.) To broaden and deepen a company's technological capabilities

Although their work is aimed entirely at directing corporate R&D efforts towards NPD, Roussel *et al's* work was representative of the latest thinking at the time of starting this research project. In chapters five and six of this thesis, the researcher adopts some of the methods described within *Third Generation R&D* for use in selecting MTA projects; for example, the use of bubble diagrams.

Winning at New Products (Cooper, 1993) represented a major milestone in advancing knowledge on how to successfully undertake NPD. Cooper developed the Stage-Gate methodology for managing NPD activities, which has now been adopted for use in hundreds of companies. The findings contained in this book are discussed in detail in chapter four.

Betz (1993) focused on the strategic management of technology. Although his book contained a chapter on implementing technology in production, it was drawn mainly from case experience and only offered anecdotal evidence from the experiences of a limited number of companies. No process models of how to carry out MTA were presented.

Karwowski and Salvendy (1994) cover a range of issues in relation to the organisation and management of advanced manufacturing technologies. The topics covered in their book are weighted towards human aspects of AMT, for example, there is a chapter on designing the human infrastructure for technology. However, other topics including investment appraisal are also covered.

Lowe (1995) focuses more on the management of technology within industry. Significant to this research is that Lowe's book contains a chapter (p134-161) on the adoption of new manufacturing technology. This chapter offers some useful guidelines when implementing new manufacturing technology, but does not offer any whole process models for project selection or a methodology for successful implementation. He states that what is required for the introduction of a new technology is a full and in-depth analysis of all of the economic and technical aspects involved, so as to establish an accurate specification of operational and performance requirements. However, no methods for undertaking this activity are presented explicitly. He goes on to discuss more specific aspects of manufacturing technology adoption including Flexible Manufacturing Systems (FMS), Computer Aided Design and Manufacture (CAD/ CAM), and Computer-Integrated Manufacturing (CIM). Despite the shortcomings of the work, Lowe offers one of the better overviews available in the technology management literature.

The Handbook of Technology Management (Gaynor, 1996) looks at technology from a systems perspective. It focuses attention on the integration of all technology-related issues and takes a broad view of technology management. It raises issues that are essential for organisations wishing to improve their performance levels and benefits from investment in technology. The book is comprised of 36 chapters under the following headings:

- perspectives on the management of technology
- methodologies, tools and techniques
- education and learning
- the new-product process
- managing management of technology
- case histories and studies

Floyd (1997) proposes an approach to undertaking R&D similar to that proposed in Third Generation R&D Management, focusing on the use of portfolio management techniques and corporate level involvement in deciding which technologies to invest in and how to exploit them for maximum commercial benefit

The most comprehensive reference book available on the subject is *The Technology Management Handbook* (Dorf, 1998) which contains 200 articles on the subject in 22 chapters, each article having been written by a technical management expert and dealing with a specific topic of Technology Management. Its introductory section states that the fundamentals of technology management have evolved to include a wide range of knowledge, empirical data, and a broad range of practice. The focus of the book is on the key concepts, models and methods that have developed to enable technology managers to effectively develop and manage the development and utilisation of technologies.

Cooper et al (1998) advanced the theory of portfolio management in NPD in their book, *Portfolio Management for New Products.* The authors presented a rigorous and practical framework for managing a company's product portfolio, investing for long-term growth. This book provided many of the methods adopted and tested by the researcher in the field of MTA and is discussed in more detail in chapter six of this thesis.

Although many other books were purchased and reviewed, the above summary gives an overview of the literature contained within the general technology management textbooks.

2.8 Stargate Literature Bibliography

During the literature review using internet search engines, the researcher found a Canadian based consultancy company (Stargate Management Consultants)[2] who have compiled a specialised bibliography on R&D and technology management

This bibliography contains complete references to over 17,000 articles, books and conference proceedings on R&D management, the management of technological innovation & entrepreneurship, science & technology policy, technology transfer, and other areas of interest to technology managers, industry/government research managers, university researchers and students.

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[2] Stargate Management Consultants' website is http:\www.stargate-consultant.ca

This bibliography is arranged into thirty-seven chapters by subject area. The chapter headings are:

1. Transition from Scientist/Engineer to Manager
2. Motivation and Effective Management of R&D Personnel
3. Rewarding R&D Personnel and Inventors
4. Management of Teams for R&D and New Product Development
5. Relationship Between Age of Technical Personnel and Productivity
6. Role and Activities of the R&D Manager/Leader
7. Personnel Activities Associated with R&D
8. Organising the R&D/Innovation Activity
9. Project Managers, Matrix and Project Management
10. Planning, Scheduling and Controlling R&D Projects
11. Idea Generation, and R&D Project Evaluation and Selection
12. Entrepreneurs/Intrapreneurs, Small High-Tech Firms and Venture Management
13. Communication and Information/Knowledge Flow in R&D
14. Technology Transfer
15. Technology Transfer to Developing Nations
16. Technology Adoption and Diffusion
17. Intellectual Property Management (Patents and Licensing)
18. University-Industry Technology Interactions
19. Intercorporate/International R&D Partnerships and Alliances
20. Corporate Science and Technology Strategy
21. Accounting and Budgeting of R&D Expenditures
22. Resource Allocation
23. Development and Marketing of New Technology Based Products/Processes and Services
24. Technological Innovation
25. Management of Science and Technology in Japan
26. Economic Studies of R&D and Technological Innovation
27. Measuring and Improving Individual, Organizational and National S&T Performance and Productivity
28. Management of R&D in Government Laboratories
29. Management of R&D in a University Facility or Research Institute
30. Technology Assessment
31. Technological Forecasting
32. R&D Contract Management
33. Government Policies and Programs in Support of Technological Innovation
34. Effects of Regulation on Technological Innovation
35. Unionisation of Scientists and Engineers

36. Conflicts of Interest, and Ethical Considerations in R&D
37. Books and Reports on R&D/Innovation Management Topics

The bibliography is available on both paper and electronic media and was purchased by the researcher. By reviewing the bibliography, the author gained additional confidence that no relevant articles had been omitted from the overall review of the literature.

2.9 Discussion

As is apparent from the comprehensive review of the literature, little guidance was found that addressed the basic research question of how to select the right MTA projects and make them succeed The publications by Tyre and Pisano were found to be interesting, but they covered only single elements of MTA. For example, neither covered selecting the portfolio of projects in the first place.

In contrast, an extensive number of publications were found to exist in the related field of NPD. More importantly for the researcher, models of how to undertake this activity successfully (based on empirical investigation) were available to the NPD practitioner. In particular, the work of Roussel *et al* (1991) and Cooper *et al* (1998) presented methods for managing the complex process of NPD. This offered an opportunity to explore these methods and their applicability to the challenge of MTA. The literature on NPD is covered in detail in chapters four and five.

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Chapter 3

Discussion of the Research Methods used.

3.0 Introduction

This chapter draws on management research textbooks to explain the reasons for selecting the various research methods used during the study. The chapter also gives some detail on how the methods were applied in different components of the research. Further details are given in later chapters. Particular emphasis is placed on reviewing the application of case study research, upon which a significant proportion of the thesis is founded.

> *"Research design is concerned with turning research questions into projects. Research design provides the link between the question that the study is asking, the data that are collected, and the conclusions drawn."* (Robson, 1993).

This chapter draws heavily on research methods from the social sciences and management research fields. At the student's third review panel meeting, Professor Keith Goffin from the Cranfield School of Management insisted that a discourse on research methods used during the research should be included as a chapter in its own right.

3.1 Research Strategy

It was part of the condition of the support given to the researcher by his Company that the findings should be particularly applicable to the needs of the sponsoring organisation. The initial period of research work was conducted external to the Company to examine the validity and necessity of the research work for manufacturing companies in general, before focusing internally through the application of case study research within the sponsoring company. The R&D Management Centre at Cranfield places particular emphasis on in-company research work aimed at researching "real-world" issues (Appendix C (i)) within students' organisations, and requires that the research work should be directly applicable to and form part of the normal work of the student. This view is endorsed by Easterby-Smith, Thorpe and Lowe (1991, p68) that when working directly for clients or patrons, as in evaluation research, it is very important to tie the research very closely to the question that the sponsors want to have answered. One of the five features considered to characterise the antecedents of successful research is real world value i.e. a problem arising from the field and leading to tangible and useful ideas (Robson, 1993).

Research Strategies have been classified in many different ways. Robson (1993) groups them into three main traditional strategies:

(1.) Experiment: measuring the effects of manipulating one variable on another variable, usually involving hypothesis testing.

(2.) Survey: collection of information in standardised form from groups of people, usually employing questionnaires or structured interviews.

(3.) Case study: development of detailed, intensive knowledge about a single case or a small number of related cases, usually involving observation, interviews and documentary analysis.

He goes on to say that the researcher should not feel confined to one method, but that it may be appropriate to use combined or hybrid strategies, as was the case in this thesis. For example, the research methods used in the single case in chapter seven draws upon multiple strategies.

Research techniques are often grouped into either qualitative or quantitative methods. However, the distinction between both methods is not always clear as some techniques, such as interviews, can be used to gather data in either a quantitative or qualitative way. Similarly, a single piece of data, such as an interview transcript, can be analysed in either way.

3.2 An Overview of the Research Methods used

This section gives an overview of the research methods used in each chapter. Table 3.1 shows the research method used in each chapter, the activity undertaken in conducting the research and the components and sequencing of each activity.

Chapter	Research Method	Activity	Components of Activity
4. Success Factors & Measures	Qualitative & quantitative – Interviews	Interviews with personnel involved in the acquisition of manufacturing technology in a range of external manufacturing companies	1. Develop questions. 2. Pilot test 3. Finalise questions for semi-structured interviews 4. Explanation letter 5. Conduct Interviews 6. Transcribe interviews 7. Content Analysis 8. Output – Factors & Measures Checklist
6. Portfolio Management and R&D Project Selection Techniques	Case Study + Evaluation Method	Test the application of Portfolio Management and Project Selection techniques to the acquisition of manufacturing technology over 3 annual cycles	1. Develop methods 2. Apply to case environment 3. Data Analysis
7. The Acquisition of a new manufacturing technology	Case Study	Single Case study on the acquisition of a new machine for the assembly of garment parts.	1. Semi-structured interviews at start of project 2. Semi-structured interviews after project completion 3. Interviews transcribed 4. Content analysis 5. Machine performance data analysis 6. Review of standard project documentation 7. Comparison of findings with Factors & Measures Checklist
8. Strategic Change Events	Survey	Review of the changes in strategy and senior management by the Company over the research period and an examination of the impact of these events on manufacturing technology acquisition activities	1. Collection and review of annual reports on company performance. 2. Capital Expenditure changes 3. R&D Expenditure 4. Organisation Structure changes using Critical Incident Chart.

Table 3.1: An overview of the research methods used in each of the chapters

3.3 Qualitative Methods

Qualitative techniques include interviews, observation and diary methods. Van Maanen (1983) defines qualitative methods as an array of interpretive techniques which seek to describe, decode, translate and otherwise come to terms with the meaning, not the frequency, of certain more or less naturally occurring phenomena in the social world. The most fundamental of all qualitative methods is that of in-depth interviewing (Easterby-Smith, Thorpe and Lowe, 1991).

3.3.1 Interviews

Interviews were chosen for data collection in chapters four and seven. In both cases, semi-structured interviews were selected as the appropriate techniques as the research was fairly exploratory in nature, thus allowing the researcher some degree of freedom to deviate from the main, pre-prepared questions when appropriate during the interviews. However, although semi-structured interviews were used to collect the data, the data analysis process was different for each of these chapters.

Interviews have been described as a conversation with a purpose (Robson, 1993). It is a conversation initiated by the interviewer for the specific purpose of obtaining research-relevant information and focused by him on content specified by research objectives of systematic description, prediction and explanation (Cohen and Manion, 1989, p.301).

The interview offers the researcher the opportunity to probe deeply to uncover new clues, open up new dimensions of a problem and secure vivid, accurate inclusive accounts that are based on personal experience (Burgess, 1982).

3.3.2 Semi-Structured Interviews

Semi-structured interviews are used where the interviewers have their shopping list of topics and want to get responses to them, but as a matter of tactics there is more freedom in the sequencing of questions, in their exact wording, and in the amount of time and attention given to different topics during the interview. The interview schedule tends to be much simpler than for structured interviews.

3.4 Research Methods used to derive the MTA Success Factors and Measures Checklist (Chapter 4)

In this phase of the research comprehensive lists were compiled of Success Factors and Success Measures in MTA, known for short as Factors and Measures. Success Factors are factors that tend to promote the success or failure of a project, whereas success measures are ways in which the outcome of a project can be judged. The literature on the success factor approach to management research is discussed in detail in chapter four. Rather than focusing solely within the sponsoring Company, it was decided to first examine the research topic in other manufacturing companies with a view to establishing success factors and measures from interviewees' own direct experiences, and to discuss the issue of manufacturing technology in general. The output from this research phase was a list of success factors and measures.

Although the interviews were exploratory to some degree, the subject matters discussed during the interviews and the questions sought to be answered were well bounded.

3.4.1 Overview of the Research Method used

An overview of the research techniques used and the actual research process undertaken for this phase of the research (Chapter four) is now given:

(1.) The semi-structured interview questions were developed and pilot tested on supervisor and colleagues. After modification, a final interview schedule of questions was completed.

(2.) A model for framing or bounding the interviews was developed (Chapter four, Figure 4.1) which assisted the researcher when exploring the manufacturing technology acquisition process for the specific projects being reviewed, and also allowed for more general themes within technology management or R&D management to be explored with interviewees.

(3.) The companies and people to be interviewed were targeted randomly through contacts and networks of colleagues of the researcher. The researcher was not familiar with any of the projects discussed, although he knew some of the companies by name. The researcher also reviewed the sample size and composition of companies with Professor Keith Goffin from the Cranfield School of Management in advance.

(4.) Preliminary contact was made by telephone with each interviewee and to seek their approval to conduct an interview. A letter followed this up to each interviewee (Appendix D (i)) before a second call was made to arrange a specific date, time and location for the interview.

(5.) The interviews were undertaken, and in all cases they were tape recorded to facilitate further analysis.

(6.) A transcript of each interview was produced. Next, sections or extracts containing statements from the interview were grouped (Appendix D.(ii)) under the following headings:

- Project description
- Means of acquisition
- Acquisition process or sequence of events
- Critical Factors – success/ failure
- Success Measures
- Key people
- Other points

(7.) Statements within the text were highlighted and coded (for example, 'F' for Factor and 'M' for Measure), and statements from all of the interviews were grouped to yield a factor or a measure. Examples of this process are given in chapter four, section 2.4.

(8.) The factors and measures were then assigned to categories developed by the researcher, before the research technique of 'Content Analysis' (section 3.5.2) was used to further analyse the data, yielding a frequency of occurrence of the factors and measures across all of the interviews (factor or measure present or not). Content analysis is described in more detail later.

(9.) A summary table of the interviews was developed (Appendix D (iii) – one page extract from summary) to assist in cross-referencing data to specific interviews.

(10.) Finally, the data was presented in a data display matrix showing the distribution of factors and measures (chapter four, section 3.2).

3.4.2 Content Analysis

Content analysis is a research technique for making replicable and valid inferences from data to their context (Krippendorff, 1980). It has also been defined as a research tool for the scientific study of speeches, records and other written communications to determine the key ideas, themes, words or other messages contained in the record (Adams and Schavaneveldt, 1985).

The aim of content analysis is to put qualitative data into a more quantitative framework (Sharpe and Howard, 1996). The essence of content analysis is to:

(1.) identify the target communications

(2.) identify a number of dimensions of the subject in hand

(3.) go through each communication assigning statements to it and group into category or dimension

(4.) count the number of times each dimension is addressed in each communication

Robson (1993) proposes the following procedure for carrying out content analysis of text:

(1.) Start with a research question

(2.) Decide on sampling strategy to reduce the task to manageable dimensions

(3.) Define the recording unit, commonly a single word although it can be paragraphs or whole items.

(4.) Construct categories for analysis. In this instance, factors, measures, key people, etc.

(5.) Test the coding on samples of text and assess reliability. The researcher followed this advice as a pilot exercise was undertaken in advance. Also, the student's supervisor was asked to code some of the reduced text independently, to test for reliability in coding and this proved to be satisfactory in that there was a high degree of correlation between the student and the supervisor.

(6.) Carry out analysis. This involves the analysis of the data to generate some statistics about the data, for example, frequency of occurrence of a word.

Content analysis can be extremely time-consuming and laborious (Robson, 1993). The researcher found that the use of word processing software aided this process greatly. However, transcribing the interviews from cassette tape to text was a lengthy task. Weber (1985) provides a review of ways in which the computer can help in carrying out content analysis.

3.5 Research Methods used in the Case Study on the application of Portfolio Management techniques (Chapter 6)

The objective of this phase of the research was to test out the application of portfolio management techniques selected and adapted from within the domain of New Product Development (NPD) and to test their application and usefulness to the domain of the acquisition of manufacturing technology. Techniques from NPD were adapted and applied to the acquisition process over three successive annual cycles of acquiring manufacturing technology. I.e. the techniques were actually used by the Company to select all manufacturing technology projects in 1996, 1997 and 1998. This research took the form of an in-company case study and contained many elements of evaluation research methods in so far as the techniques were adopted, tested, modified and reapplied in a "live" environment over three annual cycles of MTA.

The following section discusses the evaluation research methods used in Chapter six.

3.5.1 Evaluation Research Methods

An evaluation is a study which has a distinctive purpose; it is not a new or different research strategy. The purpose of an evaluation is to assess the effects or effectiveness of something, typically some innovation or intervention: policy, practice or service. This can be done using experimental, survey or case study research strategies, or some hybrid or combined strategy (Robson, 1993).

Evaluation research highlights and brings to the fore the real world aspect of the enterprise. Issues concerning clearances and permissions to undertake the research are often concerns, as is the possible impact of the research findings on activities and people within the organisation. It is intrinsically a sensitive activity. There may be a risk that it reveals inadequacy and the findings may even be misused or ignored.

Robson goes on to say that evaluation is a type of applied research that is concerned with defining real world problems, exploring alternative approaches, policies or programmes in order to seek solutions to such problems. The flexibility in design and execution of the case study, together with the fact that most evaluations are concerned with the effectiveness and appropriateness of an innovation or programme in a specific setting (i.e. that it is a case rather than a sample), make the case study appropriate for many evaluations.

Furthermore, Robson presents criteria that should be met for the evaluation to be effective:

(1.) **Utility.** There is no point in doing an evaluation if there is no prospect of its being useful to some audience.

(2.) **Feasibility.** An evaluation should only be done if it is feasible to conduct it in political, practical and cost-effectiveness terms.

(3.) **Propriety.** An evaluation should only be done if you can demonstrate that it will be carried out fairly and ethically.

(4.) **Technical Adequacy.** Given reassurance about utility, feasibility and conduct, the evaluation must then be carried out with technical skill and competency.

Importantly for the company sponsoring the research work, the utility criterion emphasizes that usefulness is at the core of the evaluation method. Another critical point is that by its very nature, evaluation research is normally conducted in a live, dynamic environment where the events are occurring in real-time. The researcher gave this considerable forethought when designing this phase of the research, as the timeline was driven by manufacturing requirements in a real business environment during each of the three years. The researcher and the Company were satisfied that the four criteria listed for successful evaluation were satisfied, so much so that the end result was that the acquisition techniques tested and applied were ultimately fully adopted by the Company as an integral component of the policy for acquiring manufacturing technology.

It is worth mentioning that evaluation programmes are normally set up because a perceived need is not being met by current provision. This was indeed perceived to be the case in Fruit of the Loom. Its traditional approach to manufacturing technology assessment and acquisition used primarily traditional financial tools, payback or discounted cash flow analysis, for deciding on projects. The inadequacy of these financial methods was reinforced by the fact that the Company had experienced multiple failures of manufacturing technology projects.

Before embarking on this case study using the evaluation method, the following checklist of questions adapted from Harlen and Elliott (1982) was used to both plan the research and to frame the context in which the research would be carried out:

(1.) Reasons, purpose and motivation
  - Is the evaluation for yourself or someone else?
  - Why is it being done?
  - Who should have the information obtained?

(2.) Value
  - Can actions be taken as a result?
  - Is somebody or something going to stop it being carried out?

(3.) Interpretation
  - Is the nature of the evaluations agreed between those involved?

(4.) Subject
  - What kind of information is needed?

(5.) Evaluator
  - Who gathers the information?
  - Who writes any reports?

(6.) Methods
  - What methods are appropriate to the information required?
  - Can they be developed and applied in the time available?
  - Are the methods acceptable to those involved?

(7.) Time
  - What time can be set-aside for the evaluation?
  - How much time is needed?

- Is this adequate to gather and analyse the information?

(8.) Permission and Control

- Has any necessary permission been sought and received?
- Is participation voluntary or compulsory?
- Who decides what goes in any report?

(9.) Use

- Who decides how the evaluation will be used?
- Will those involved see it in a modifiable draft version before release?
- Is the form of the report appropriate for the audience?

All of the above issues were agreed with senior manufacturing management in the Company in advance of the evaluations being undertaken. This was necessary too due to significant expenditures affected by the research activity. In 1998 the budget for projects was U.S.$1.5 million and the adaptation of the Portfolio methods and project selection techniques determined directly how this money was to be allocated and ultimately spent.

3.6 Research Methods used in the Single Case Study of the acquisition of a new manufacturing technology (Chapter 7)

The objective of this component of the work was to examine the research issues studied so far at a more detailed level by examining events surrounding a single manufacturing technology acquisition project. Up to this point in the research, reasons for project success and failure had been examined in the literature and in external companies; portfolio management and project selection techniques had been adopted from the field of new product development and tested in the Company over a three-year period. It was now appropriate to examine the issues at a more detailed level during a single project. The sponsoring Company planned to acquire a new loading machine for feeding tee shirt sleeves to an automated sewing system. This project was typical of the type of project being undertaken by the Company and was chosen for an in depth study solely because the timing of the acquisition coincided with this period of the research. The decision was made to use the case study method as the project under review was multifaceted.

3.6.1 Case Study Method

Yin (1993) states that case study research is:

> *"the method of choice when the phenomenon under study is not readily distinguishable from its context. Such a phenomenon may be a project or program in an evaluation study."*

Furthermore, he goes on to say that the inclusion of context as a major part of a study creates distinctive technical challenges. First, the richness of the context means that the ensuing study will likely have more variables than data points. Second, the richness means that the study cannot rely on a single data collection method but will likely need to use multiple sources of evidence, converging on the same set of issues. Third, even if all the relevant variables are quantitative, distinctive strategies will be needed for research design and analysis. A continuing priority is to consider case studies as a method not employing any particular form of data collection – which can be quantitative or qualitative (Yin, 1993).

Robson (1993) defines Case Study as:

> *"a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence."*

He goes on to say that case study is defined solely in terms of its concentration on the specific case, in its context. In principle, it can be as pre-structured or as emergent as desired, or as is appropriate for the purposes of the case study. Most case studies are likely to fall between the extremes of a tight pre-structured case and a loose emergent one.

Yin (1993) holds the view that the complete case study method should specify the conditions for:

- Designing an investigation
- Collecting the pertinent data
- Analysing the data
- Reporting the findings

In designing a case study the following four components are needed (Robson, 1993):

(1) a conceptual framework

(2) a set of research questions

(3) a sampling strategy

(4) a decision on methods and instruments for data collection

3.6.1.(a) Conceptual Framework

A conceptual framework covers the main features (aspects, dimensions, factors, variables) of a case study and their presumed relationship. It is needed in order to be explicit about what is being done. Most conceptual frameworks take the form of diagrams as opposed to narratives and are commonly used in the instances of a single case study. The conceptual diagram for this case is shown in figure 3.1.

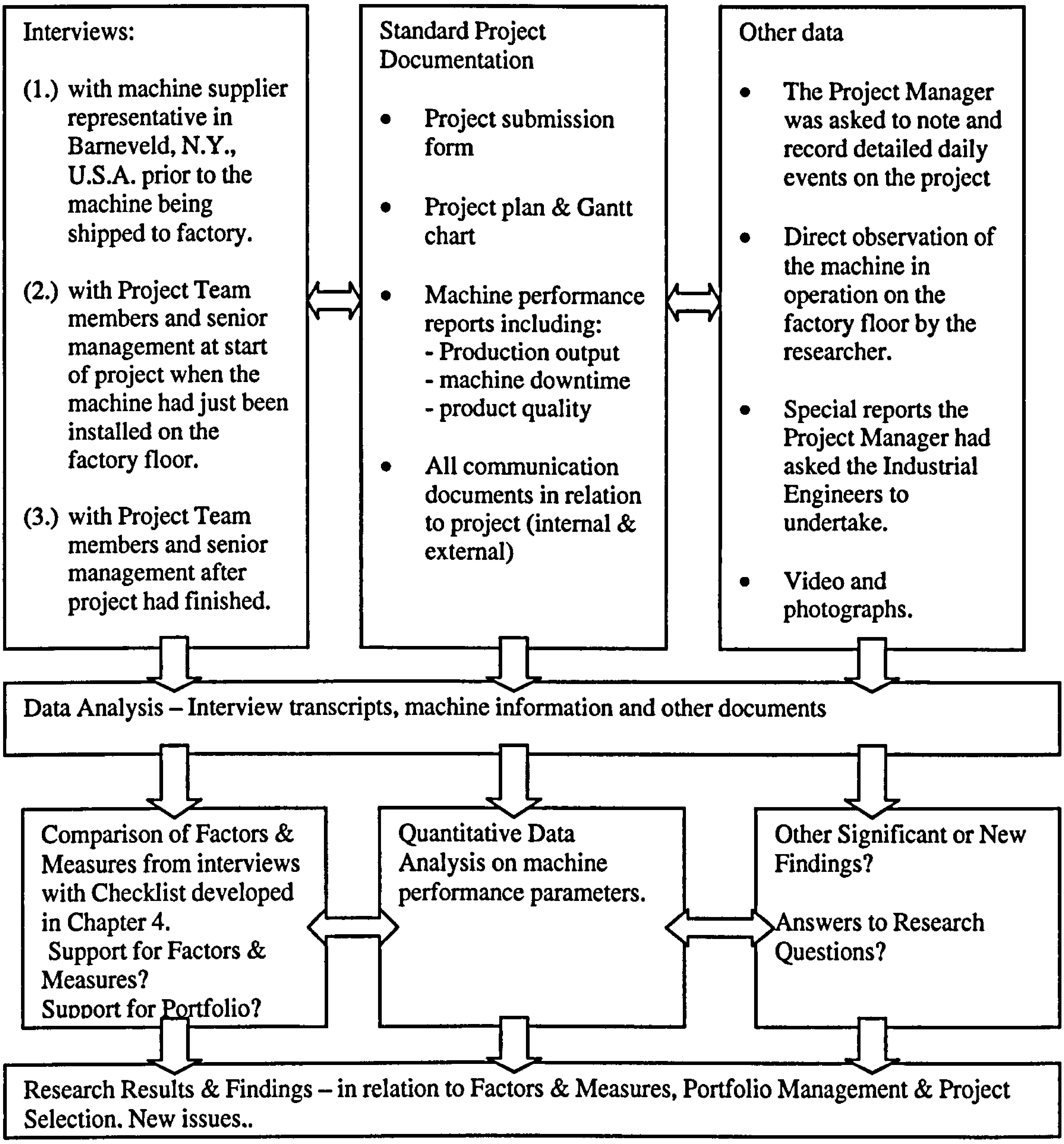

Figure 3.1: Conceptual Framework for Case Study on
a single new technology acquisition project in chapter 7.

3.6.1.(b) A Set of Research Questions specific to the Case

The conceptual framework enables the research questions to be structured and framed. In this particular case, the project investigated was the acquisition of a new manufacturing machine for automating part of a sewing process. Leading on from the earlier research work, examples of typical research questions included:

- What goes on during the acquisition of a new machine?
- Was the project likely to be successful or would it be a failure?
- What factors would contribute to success or failure?
- How was success measured?
- How do these factors and measures compare to those in the literature or those determined from the earlier work by the researcher?
- What role did the project team play?
- Who were the key players?
- What were the most important events?
- What went right and what went wrong?
- What would the machine performance data indicate?
- How would the output and performance of the machine compare with the information supplied by the machine supplier?

The key point is that it is the set of research questions that drives the data collection process and requirements.

3.6.1.(c) Developing a Sampling Strategy

Although case studies need not be quantitative in nature, it is still important to consider sampling as it is just not possible to consider everything. Also, case studies in the real world tend to be happening in real time, putting added emphasis on the researcher's ability to capture relevant data. Therefore it is likely that some selection will be necessary, and the following questions may assist in determining the sample:

- Who – which persons will be observed, interviewed, etc?
- Where - about which settings are data collected?
- When - at what times, frequency?
- What – events, activities or processes are to be observed, etc?
- How – will data be collected and processed?

For example, in the case under consideration, a decision on who to interview was determined ahead of the project starting. In this particular case, the researcher felt that it was important to interview key players in the Fruit of the Loom project team involved with and responsible for the implementation of the equipment in the factory, and also representatives of the company from which the machine was being acquired

3.6.1.(d) Selection of the Data Collection Techniques

The next consideration in the design stage was to decide how to get the information. With case study research, this normally takes the from of a range of techniques and a summary of commonly used techniques, suggested by Robson (1993), includes:

(1.) Observation.

- *Participant observation.* The investigator takes on a role other than that of a passive observer and participates in the events being studied.

- *Systematic observation.* Use of standardised observation instrument.

- *Simple observation.* Passive unobtrusive observation.

(2.) Interview.

- *Open-ended interview.* No pre-specified set or order of questions; little or no direction from interviewer; goal is typically to gain insight into a person's perception in a given situation

- *Focused interview.* Use of interview guide specifying key topics; order of questions not fixed.

- *Structured interview.* Standardised set of questions.

(3.) Use of documents and records.

- *collection of written or recorded materials including minutes, reports, etc.* In the interest of triangulation, the documents serve to corroborate the evidence from other sources. They are also useful for making inferences about events. In the case in chapter seven, the standard project documentation and reports were collected, as well as any additional evidence in the form of data sheets, correspondence with supplier (emails and facsimiles), and the project manager's daily notes.

3.6.2. Multiple or Single Case Study Method?

Case study research can be based on single or multiple case studies. Further, whether single or multiple, they can be exploratory, descriptive, or explanatory. A single case focuses on a single case only, whereas multiple case studies include two or more cases within the same study.

An exploratory case study is aimed at defining the questions and hypothesis of a subsequent study or at determining the feasibility of the desired research procedures. A descriptive case study presents a complete description of a phenomenon within its context. An explanatory case study presents data bearing on cause-effect relationships - explaining which causes produced which effects (Yin, 1993).

Single cases are used to confirm or challenge a theory, or to represent a unique case. (Yin, 1994). Single case studies are also ideal for revelatory cases where an observer may have access to a phenomenon that was previously inaccessible. Single case designs require careful consideration to maximise the investigator's access to the evidence.

In chapter seven, a single case was chosen because:

- it afforded the opportunity to explore a project in exceptional detail while it was actually happening – a "unique" opportunity. More data could be collected than would have been possible if reviewing multiple cases over the same period. The transcripts of the interviews conducted by the researcher contained just over 34,000 words and other project data and documentation required two lever arch files for storage, so it was not feasible to conduct more than one such case.

- multiple cases or projects had already been examined at a higher level.

3.6.3. Semi-Structured interviews at the start of the Case Study

Semi-structured interviews were conducted at the start of the case study. Firstly, the researcher accompanied the Project Manager and the Head Automation Engineer to the machine supplier's headquarters in Barneveld, New York State, U.S., where they had travelled to assess the machine technically on-site prior to its being shipped to the factory in Ireland. They were there to see it in operation, to undertake preliminary training, and to sign-off that it was ready to be shipped and implemented in a production environment in Fruit of the Loom, Ireland. The researcher used this opportunity to interview the President of the supplier company, Jet Sew Technologies, Inc., and the Programme Manager for this machine.

Once the machine was installed in the factory and was operational for a few days, the researcher carried out interviews with members of the project team in the factory. In this Auto Loader Case Study, all interviewees were briefed in advance on the format and purpose of the interviews. An example of the interview sheet used is given Appendix G (vi). However, as is expected with semi-structured interviews, the actual interview transcripts illustrate that many other aspects of the projects were explored depending upon how the interviews proceeded. An example of full interview transcripts is given in Appendices G (ii) and G (vii).

A second series of interviews was conducted with key project team members and senior management after the project had been completed, to explore their views on events surrounding the project and to discuss the outcome of the project. The same data collection and analysis process was used for the post-project interviews as was used at the start of the project.

3.6.4. Traditional Sequential Analysis of Qualitative Data

The traditional sequential analysis of qualitative data (Miles and Huberman, 1994) was used in this Case Study. Figure 3.2 illustrates the process steps in this qualitative research method.

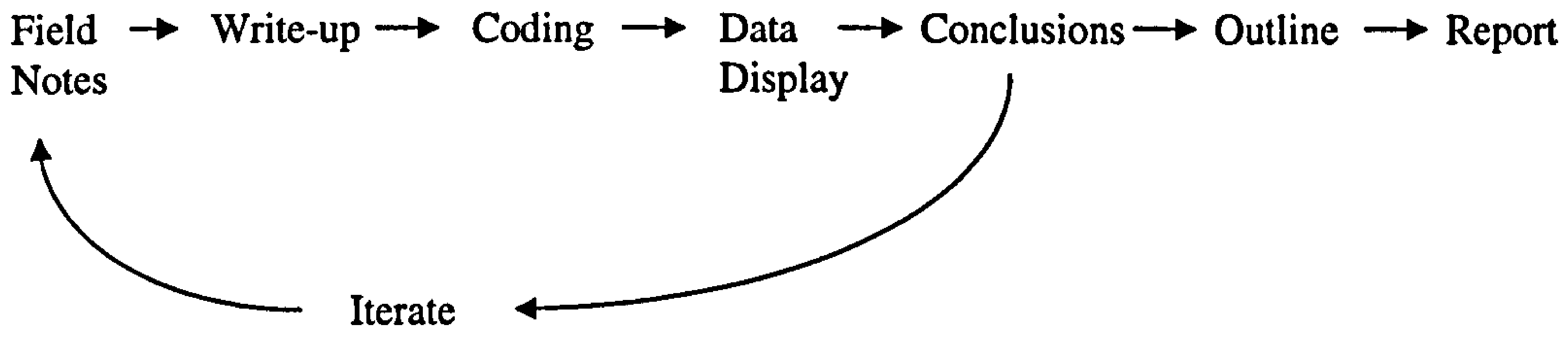

Figure 3.2: Traditional Analysis Sequence
(Miles & Huberman, 1994, p.85)

In this process, field notes in relation to the case are generated and written up on an ongoing basis throughout the data collection stage. They can often take the form of interview transcriptions of unreduced text. Where necessary, codes can be applied to the data or text, or key themes in text are highlighted or underlined. The next step is to compress the text data into some form of Data Display, to assist the researcher to understand the events and processes under study. Typically, they fall into two categories: matrices, with defined rows and columns, and networks, with a series of nodes which link them. This procedure is iterated until data collection and the completed case is done. Next, conclusions on the case can be drawn and/or a case report generated.

3.6.5. The Ladder of Analytical Abstraction

Qualitative studies are often mounted to explore a new area and to build or develop a theory about it, but they can also be designed to confirm an existing theory. In the confirmatory mode, as Gherardi and Turner (1987) point out, data are used to fill in gaps in a puzzle. They go on to say that in the exploratory mode, it is as if we are trying to solve an unstated or ambiguous problem, which has to be framed and reframed as we go.

As part of the process of moving from describing to explaining case data, there is a natural progression. This natural progression, as Rein & Schon (1977) suggest, is from telling a first story about a specified situation (what happened, and then what happened next?), to constructing a map (formalizing the elements of the story), to building a theory or model (how the variables are connected, how they influence each other).

This progression has been described as a "ladder of progression" (Carney, 1990). See Figure 3.3. You begin with a text, move on to identify themes and trends, and then to testing hunches and findings, aiming eventually to integrate the data into an explanatory framework. In this sense, the data is being transformed as information is condensed, clustered, linked and sorted over time (Gherardi and Turner, 1987). There is no clear or clean boundary between describing and explaining; the researcher typically moves through a series of analysis episodes that condense more and more data into a more and more coherent understanding of what, how, and why (Miles and Huberman, 1994).

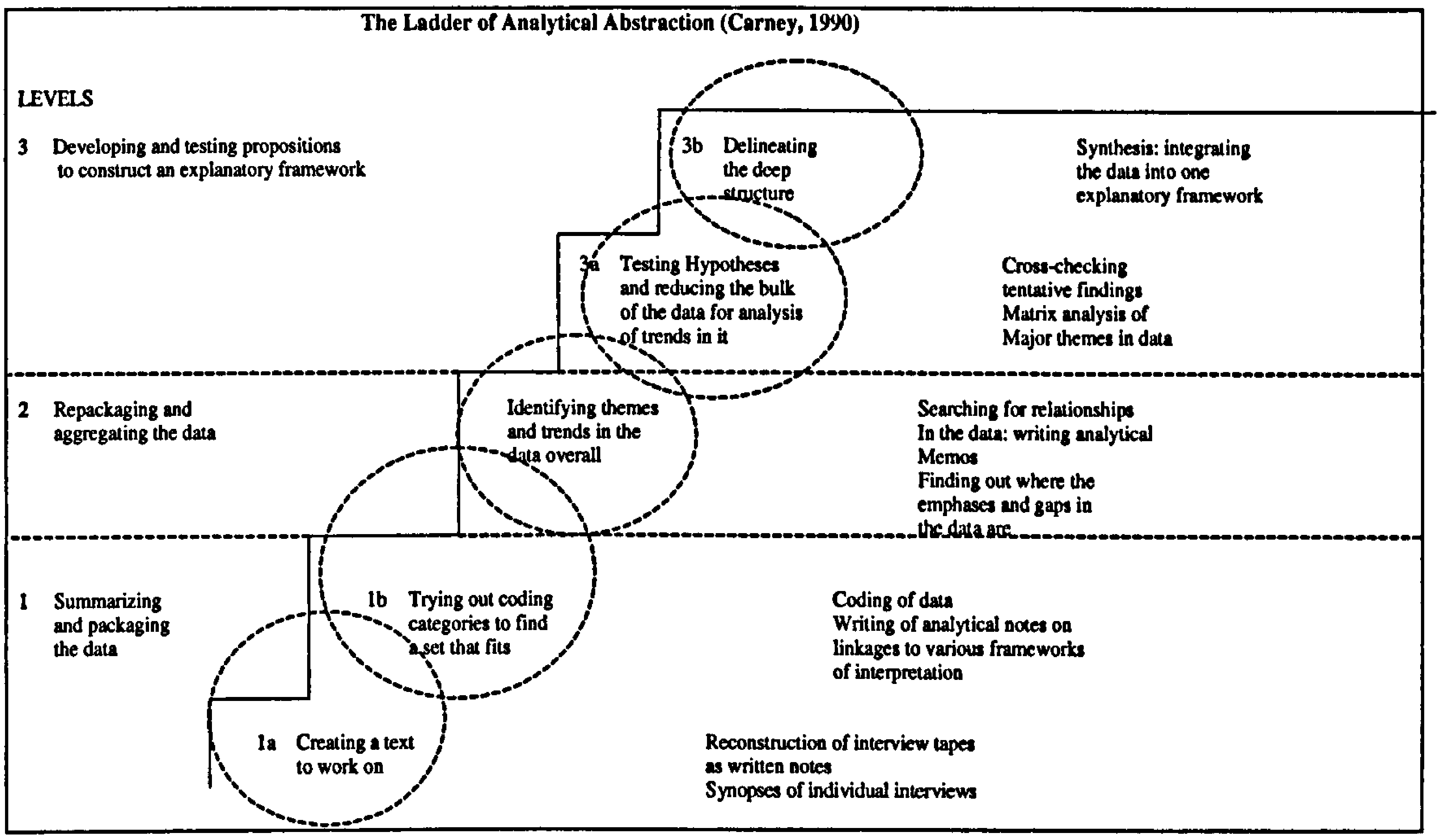

Figure 3.3: The Ladder of Analytical Abstraction showing progression from raw data through to an explanatory framework.

Part of the process of analytic transformation of unreduced text involves a general condensation of the data and the creation of a "general psychological structure", as proposed by Miles and Huberman (1994). Here the analysis is nested in a more conceptual framework – is connected to a body of knowledge lying outside the data set, for example the previously determined factors and measures checklist derived in chapter four. In the case of the Auto Loader project, the condensed data in the form of clusters or vignettes of text were contrasted against the success factors checklist. Typical steps in the analytical process include:

- Underline key terms in the text.
- Restate key phrases.
- Reduce the phrases and create clusters.
- Reduction of Clusters and attach labels.

- Generalisations about the phrases in each cluster.
- Generating minitheories.
- Integrating theories in an explanatory framework.

The researcher adhered closely to these process steps in the analysis and reduction of the qualitative data. However, there was a focus on contrasting and testing the data against methods (factors and portfolio) derived from earlier work by the researcher.

3.6.6. Examples of Clusters

Each of the interviews was recorded and then input to a Microsoft Word document. Then, in line with the analytical progression described previously, the interviews were reviewed a number of times and key terms and phrases highlighted in the text. Labels were then attached to the clusters, some referring to specific success factors and measures mentioned in the interviews, and some labels referring to more general project issues. Examples of an interview transcription that illustrate this analytical approach are shown in Appendix G (vii) and examples of Clusters are given in chapter seven, section 10.3.

3.6.7. Triangulation

A fact may be considered to have been established robustly if three or more sources all coincide. Consider the difficulty of establishing the occurrence of an event. There would be more confidence is saying that the event had actually occurred if the study showed that information from interviews, documents and researcher observation all pointed in the same direction. This type of triangulation is the most desired pattern for dealing with case study data, and the researcher should always seek to attain such an outcome. An important clue is to ask the same question of different sources of evidence: if all sources point to the same answer, the data has been successfully triangulated (Yin, 1993).

Even at the stage of designing a conceptual framework for the automatic loader machine case study, the researcher had taken triangulation into consideration in designing the research approach, having decided to use multiple sources of evidence including interviews, performance data, documentation and observation before embarking on the data collection phase. By using a combination of observations, interviewing, and document analysis, the fieldworker is able to use different data sources to validate and crosscheck findings (Patton, 1990).

Three criteria against which qualitative data and data analysis are judged are validity, reliability and rigor. While there is no uniformly agreed-upon set of validity and reliability criteria for case studies, validity generally refers to the accuracy and value of the interpretations, and reliability is the extent to which other researchers would arrive at the same results if they studied the same case using the same procedures. Merriam (1998) describes rigor as:

> *"Rigor in qualitative research derives from the researcher's presence, the nature of the interaction between the researcher and participants, the triangulation of data, the interpretation of perceptions, and rich, thick description".*

3.6.8. Summary of the Case Method

The case method is well established in the field of qualitative research tradition. As a methodology, it is especially responsive to research questions of why and how, and it offers a flexible yet integrated framework for holistic examination of a phenomenon in its natural state or environment. The design of a case can be customised to address a wide range of research questions and types of cases and to incorporate a variety of data collection, analysis and reporting techniques. It is exceptionally useful for exploratory research and theory generation and is particularly appropriate for applied research related to contemporary issues of events or people in the real world.

3.7 Research Methods used in Strategic Change Events (Chapter 8)

The impact of changes in strategy on manufacturing technology acquisition within Fruit of the Loom was examined in chapter 8. This element of the research was undertaken as it was found that strategic change had a significant impact on technology acquisition activities, as became evident in the single automated loader project in chapter seven.

This phase of the research involved the collection of data in the form of company records, annual reports, financial data, memorandums and statements for the period 1994 to 2001. This data was then analysed and key changes in strategy reviewed against their impacts on manufacturing technology acquisition activities. Included in the analysis were stated strategic statements and changes in senior management during the period.

The researcher was seeking to find out if and how consideration of Company strategy would impact on the models adopted from the new product development field.

3.8 Summary

This chapter has reviewed the methodologies used to carry out the research, and explained why particular research methods were chosen for the various components of the research work. Particular emphasis was placed on evaluation and case study research techniques, as they were the primary methods applied.

Rigor and systematic data collection are important. But what is particularly important is the usefulness of the data for the purposes of the evaluation, and not the method by which it is obtained (Robson, 1993). In essence, the overriding message in all of the research methodology books is for the researcher to use whatever tools are necessary to get the job done.

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Chapter 4

Success Factors and Measures.

4.0 Introduction

This chapter reviews the literature on success factors and measures found in the overlapping fields of R&D management and new product development (NPD). It then reports how a list of success factors and measures for MTA was derived from interviews with key players from a number of manufacturing companies.

4.1 The Literature on Success Factors and Measures in New Product Development and R&D

Many research studies have attempted to discover the critical factors that can predict the success or failure of R&D projects and new product introductions. Some have looked at factors causing success in new product introductions, some have looked at factors causing failure and others have looked at both sets of factors. The studies show that there are many factors influencing the success of a new product or an R&D project, which is aimed at developing a new product. Some of the factors are controllable from within the organisation but others are external and uncontrollable. Much can be learned from observing successful new products. Equally, there is much to be gained from doing post-mortems on failures.

4.1.1 Project SAPPHO

The first investigation to undertake a comparison of project success/ failure factors was conducted in 1972 by the Science Policy Research Unit (SPRU) of Sussex University in the U.K. SAPPHO stands for Scientific Activity Predictor from Patterns with Heuristic Origins, and was a study carried out into what factors are associated with success in R&D projects.

This classic study compared and contrasted 43 pairs of successful and unsuccessful products in the same industries, to identify factors that led to success. Interviews were used to measure the presence or absence of a large number of factors for each project, such as government financial support, a project champion, etc. Correlation analysis was then used to determine empirically which factors tend to be associated with success and with failure of the projects. The most important discriminators between winners and losers were, in rank order:

- understanding of users' needs
- attention to marketing and launch publicity
- efficiency of development
- effective use of outside technology and external scientific communication
- seniority and authority of responsible managers

Note that the first two factors were market-related and not the expected technological and technical prowess factors.

The SAPPHO researchers also reported the results of a five-country study of innovation in the textile machinery industry. Here the focus was on firms rather than projects. High performance firms shared certain characteristics:

- they had superior marketing capabilities and frequent customer contact
- they understood users' needs and were able to assess whether these needs could be met economically

- they carefully matched specific sales strategies to market requirements

Firms that employed qualified scientists and engineers were more able to produce successful breakthroughs and more radical innovations stemmed from firms with technically qualified chief executives (Rothwell, 1978).

4.1.2 Kulvik's Studies

Kulvik's (1977) study of successes and failures in Finland yielded similar results to those of SAPPHO, but identified additional facilitators, namely various synergies:

- a good "company/ product fit"
- the utilisation of technical know-how in the company
- familiarity with both the new product's markets and its technologies.

4.1.3 Booz, Allen & Hamilton Studies

An investigation of new product practices in 700 firms by Booz, Allen & Hamilton (1982) identified a number of characteristics that contributed to higher new product success rates:

- product fit with market needs
- product fit with internal functional strengths
- technological superiority of the product
- top management support
- use of a formal new product process

- favourable competitive environment
- structure of the new product organisation

The study then went on to determine the existence of common characteristics in companies which were more successful with their new products. Here are some of the differences between successful and unsuccessful firms:

(1) Operating philosophy: Successful companies are more committed to growth through new products developed internally. They are more likely to have had a formal new product process in place for a longer period of time. They are more likely to have a strategic plan that includes a certain portion of company growth from new products. They are also likely to prescreen new product ideas more thoroughly, and process almost 10 times fewer new product ideas per successful new product than unsuccessful companies.

(2) Organisation structure: Successful companies are more likely to house the new product organisation in R&D or engineering and are more likely to allow the marketing and R&D functions to have greater influence on the new product process. They also keep the senior new product executive in place for a longer period of time.

(3) The experience effect: Experience in introducing new products enables companies to improve new product performance. New product development costs conform to the experience curve: the more you do something, the more efficient you become at doing it. For the 13,000 new product introductions studied in these 700 firms over a five-year period, the experience effect yielded a 71 percent cost curve; at each doubling of the number of new product introductions, the cost of each introduction declined by 29 percent. This experience advantage stems from the

acquisition of knowledge of the market and of the steps required to develop a new product.

(4) Management styles: Successful companies appear not only to select a man-management style appropriate to immediate new product development needs, but also to revise and tailor that approach to the type of new product opportunities. Three styles were identified:

- an "entrepreneurial" approach, associated primarily with new-to-the-world products.
- a "collegial" approach associated with entering new businesses and adding new items to existing lines.
- a "managerial" approach, most often associated with developing new products that are closely linked to existing businesses.

The study concludes with a list of "best practice prescriptions" for new product management, as follows:

(1) Commitment: Firms must make a long-term commitment to new products. They must look inward for their future product opportunities, and be committed to internal product development as the major source of growth. They must be willing to mount well-defined new product efforts that are driven by common objectives and strategies. They must support these efforts with consistent commitments of the necessary funds, as well as management and technical skills.

(2) Strategy: At the core of a company specific approach to a sound new product program is a well-defined new product strategy. A new product strategy links the new product process to company objectives, and provides

focus for idea/ concept generation and guidelines for establishing appropriate screening criteria. The outcome of new product strategic planning is a set of strategic roles, used not to generate specific new product ideas, but to help identify markets for which new products will be developed.

(3) Process: A multi-step new product process has been known for some time to be an essential ingredient in successful new product development. This study introduces a new step in this process, namely strategy formulation. This focuses the search for ideas, reduces the attrition rate of ideas, and contributes to a higher success rate. The net result of the improved process has been better expenditure allocations; companies have been able to increase the portion of total new product expenditures going to products that are ultimately successful.

4.1.4 Cooper's NPD

Cooper's (1980) original "Project NewProd" in the late 1970's and early 1980's was an exploratory study into success versus failure, which sought to identify those characteristics that separated 102 new product successes from 93 failures in 102 industrial product firms. Three important factors were uncovered that distinguished successes from failures:

1. A unique, superior product in the eyes of the customer - one with a real differential advantage in the marketplace.

2. A strong market orientation, building in solid market knowledge and sound market inputs including undertaking the market research and marketing launch tasks well.

3. Technological synergy (both development and production technology) and competence in the technological tasks in the project.

Secondary factors that also had an impact on success included marketing and managerial synergy (a good fit between the needs of the project and the firm's marketing and managerial resources); positive value-in-use for the customer (the product saved the customer money over its lifetime); dynamic market situations (customer needs in a state of flux, and competitors launching many new products); large, high-need growth markets; a strong marketing communications, sales force, and launch effort; and finally weak competitors (whose customers were dissatisfied with them).

By studying what the successes shared in common, and how they differed from failures, critical success factors were uncovered. Up to here, not much attention had been given to what was actually meant by "success" of a project.

Cooper found that there is a pattern to success: indeed, significant differences emerge between successful and unsuccessful projects when one looks at the nature of the product and market, the level of synergy, and other strategic variables, along with activities undertaken as part of the project. In Cooper's study, new product success was defined in a number of ways, including:

- a simple success/failure measure: whether the product's profits met or exceeded the company's financial or profitability criterion for success
- the actual amount of profit
- the new product's market share after a period of three years
- the degree to which the product met company profit and sales objectives (a combination of the above)

Thus, MTA research should aim not only to identify Success Factors, i.e. what causes success, but also Success Measures, i.e. how to judge its achievement.

The following section draws heavily on Cooper's writings in his book, Winning at New Products (1993), where he reported that new product success was most strongly decided by the following ten key factors:

1). A superior product that delivers unique benefits to the user

Firstly, Cooper (1993) found that superior products that deliver real and unique advantages to users tend to be far more successful than what he calls "me too" products with few positive elements of differentiation. When high-advantage products (the top 20 percent) were contrasted with those with the least degree of differentiation (the bottom 20 percent), superior products were found to:

- have an exceptional success rate of 98.0 percent, versus only 18.4 percent for undifferentiated ones
- have a market share of 53.5 percent, versus only 11 .6 percent for "me too" type new products, i.e. products that are follow previous lead products or copy products
- have a rated profitability of 8.4 out of 10 (versus only 2.6 out of 10 for undifferentiated products)
- meet company sales and profit objectives to a greater degree than did undifferentiated products

These winning products offered many unique features not available on competitive products; they met customer needs better than competitive products; they had higher relative product quality; they solved a problem the customer had with a competitive product; they reduced the customer's total costs; and they were innovative - the first of their kind on the market.

Cooper (1993) found that these ingredients of a superior product provide a useful checklist of questions in assessing the odds of success of a proposed new product project. In short, the six items just listed logically become top-priority questions in a project-screening checklist. The central role of product superiority also provides prescriptions for the management of the new product process. The development of a new product with real advantages and customer benefits becomes paramount. Cooper comments that simply being "equal to the competition" or "having good product market fit" is not enough; the goal must be superiority and advantage.

2). A well-defined product prior to the development phase

The next success factor determined by Cooper revolved around having a well-defined product before undertaking development. He found that projects that had clear definitions were 3.3 times as likely to be successful; had higher market shares (by 38 points on average); were rated 7.6 out of 10 in terms of profitability (versus 3.1 out of 10 for poorly defined products); and did better at meeting company sales and profit objectives. Before a project proceeded to the development phase, winning products had clear and agreed definitions of items such as the target market, customer needs and wants, and product's specifications and requirements.

3). Quality of execution of technological activities

The third success factor was related to the quality of execution. Cooper found that projects where the technical activities were carried out in a quality fashion were significantly more successful. For example, they had 2.5 times the success rate; and a higher market share by 21 percentage points. These successful products had particularly high ratings for quality of execution for actions such as: the preliminary technical assessment, product development, in-house product or prototype testing, pilot production, and production start-up. How well these technological tasks are undertaken is strongly tied to new product success, according to Cooper. The challenge for management is to build quality of execution into the new product process by design rather than as an afterthought.

4). Technological synergy

Next, Cooper found that successful projects featured a strong fit between the needs of the project and the firm's R&D or product development resources, its engineering skills and resources, and its production resources and skills. Such products had 2.8 times the success rate, and were rated higher in terms of profitability and in meeting company sales and profit objectives. He states that the ability to leverage in-house technological strengths and resources is a key success factor. These elements of technological synergy are critical screening criteria in the evaluation and prioritisation of projects.

5). Quality of execution of predevelopment activities

Cooper comments that products that feature a high quality of execution of activities before the development phase are more successful. These products had:

- a success rate of 75.0 percent (versus only 31.3 percent for projects where the predevelopment activities were found lacking)

- a higher-rated profitability (7.2 out of 10 versus only 3.7 for projects where predevelopment activities were deficient)

- a market share of 45.7 percent (versus 20.8 percent).

These key predevelopment activities included: initial screening, preliminary market and technical assessment, detailed market study, and business or financial analysis.

These five key predevelopment activities must be built into the new product process as a matter of routine rather than by exception. Unless these predevelopment actions are carried out well, then product definition is likely to be weak and vague.

6). Marketing synergy

The next critical success factor Cooper found was what he termed "marketing synergy". Successful products feature a strong link between the needs of the project and the firm's sales force and distribution systems, its advertising resources and skills, its marketing research and intelligence resources, and its customer service capabilities. i.e. marketing synergy. Where marketing synergy existed, the success rate was 2.3 times as great; the rated profitability was higher (a rating of 6.6 versus 3.7 out of 10); and market share was 14 points higher than for products where marketing synergy was lacking. These four measures of marketing synergy form the criteria for screening and selecting projects.

7). Quality of execution of marketing activities

Success factor number seven established by Cooper's work referred to the execution of marketing activities. He found that many companies were particularly deficient in the way they handled the marketing side of projects. Success was more often the result when the following activities were well executed: preliminary market assessment; detailed market study or marketing research; customer tests of the product prototype or sample; the trial sell or test market; and the market launch itself. When these activities were well executed, the success rate was 2.2 times as great as when they did not happen, and market share rose 18.5 points. Cooper (1993) found that:

> *"too often these actions were not an integral facet of the project, and when done, were often included as an afterthought or were poorly researched. The message is that a strong market orientation coupled with quality of execution of these vital actions is essential".*

8). Market attractiveness

The eighth success factor established by Cooper was that products targeted at more attractive markets were more successful. They had a 1.7 times higher success rate than those of non-attractive markets, and also were rated much higher in terms of profitability and meeting sales and profit objectives. But market shares were only marginally higher in such attractive markets. In his study, he defined attractive markets as:

> *"large ones with a high growth rate, and markets in which the customer had a high need for the product and considered the purchase to be an important one".*

9). The competitive situation

This factor was originally thought to affect success significantly, but was found to have a lower impact than expected. Products aimed at highly competitive markets were only marginally less successful than those targeted at less competitive markets. Cooper defined Competitive markets as:

"those markets with intense competition, considerable price competition, high-quality and strong competitive products, and competitors whose sales force, channel system, and service was rated as strong".

10). Top management support

Finally, Cooper found that top managers supported failures with almost the same frequency as successes. That is, top management support seemed to make little difference to the success rate and other measures of performance. Those projects where top management was committed, was involved directly in the management of the project, and provided considerable guidance and direction for the project were only marginally more successful. Surprisingly, this contradicts the findings of Project SAPPHO (1972) and later studies by Balachandra and Friar (1997).

4.1.5 Summary on NPD work.

What emerges from the many studies into new product success and failure is that clear patterns exist. New product success is not a matter of luck. It is predictable and in many cases quite controllable. Overall, factors that describe the way the project is organised and undertaken, actions, process, and players dominate the list of reasons for success. In contrast, factors that describe the nature of the marketplace, the competitive situation, the existence of certain resources and synergies in the firm are somewhat less important.

Of the hundreds of characteristics measured in Cooper's NewProd, only the ten factors outlined above had any consistent impact on success. These ten factors were not all equal and there were distinct patterns to the results found in his study.

The completeness of the new product process can account for 75 percent of the variability in new product performance. Leaving out steps or activities drops the success rate dramatically (Cooper, 1993)

4.1.6 Balachandra & Friar's Contextual Framework

Balanchandra and Friar (1997) conducted an extensive review of the literature on factors for success in R&D projects and new product introduction. They started by examining over 60 papers in the fields of R&D projects and NPD. Next, they focused in on a smaller number of studies selected using the following criteria:

(1) The study should have some degree of empirical support

(2) The study should identify a specific set of factors as being important to success or failure

(3) Only one major study from an author or team should be considered (to make the task manageable)

Nineteen studies met these criteria. They analysed the characteristics of the studies and identified the list of significant factors in NPD and R&D projects. The list of factors contributing to success/ failure, taken from all the studies, totalled 72 individual factors. This was deemed by the researchers to be a very large number.

To provide a better understanding, the factors were further classified into four main categories: market, technology, environment, and organisation. A summary of the studies selected is shown in Table 4.1.

The number of factors identified per study ranged from a low of 3 to a high of 20, with an average of 8.1 factors per study. However, after further analysis and processing, the maximum number of factors was reduced to 16 when the authors tabulated only the final list of factors regarded as significant in each of the studies.

No.	Studies	Study Type	No.of Industries	No.of Firms	Sample Size	No.of Factors	Success/ Failure	Context
1	Baker et al (1986)	R&D	1	21	211	4	S/F	General
2	Balachandra and Raelin (1984)	R&D	12	40	114	13	S/F	General
3	Carter (1982)	R&D				20	S/F	Experience
4	Cochran and Thompson (1964)	NPD		87	87	8	F	General
5	Cooper (1981)	NPD		103	195	7	S/F	Industrial
6	Frohman (1982)	NPD	7	9	9	3	S	High Tech
7	Gaynor (1990)	R&D				6	S	Experience
8	Hopkins (1981)	R&D					S/F	Anecdotal
9	Islei et al (1991)	R&D	1			8	S	Pharm
10	Link (1987)	NPD	13	135	135	6	S/F	Industrial
11	Maidique and Zirder (1984)	NPD	4	59	118	8	S/F	High Tech
12	Mansfield and Wagner (1975)	NPD	4	20	330	6	S	Industrial
13	Marquis (1969)	NPD	5	121	567	4	S	Industrial
14	Merrifield (1981)	R&D				12	S/F	Experience
15	Pinto and Slevin (1987)	R&D			52	10	S	Projects
16	Rothwell - SAPPHO (1974)	NPD	2		86	5	S/F	High Tech
17	Rubenstein et al (1976)	R&D	6	6	103	14	S	Projects
18	Souder (1987)	NPD	10	53	235	6	S/F	R&D Intensive
19	Yoon and Lilien (1985)	NPD	6	52	100	5	S/F	Industrial
	Average		5.9	58.8	167.3	8.1		

Table 4.1: Summary of studies on success factors.

Balachandra and Friar (1997) then developed a matrix showing the complete list of 72 factors and which of the 19 studies identified the factors. This is shown in Table 4.2. The factors were grouped into a market (M), technology (T), organisation (O) or environment (E) related factor listing. In the matrix, those factors influencing the success of the project in a positive manner were coded ' + ', those having a negative influence with a ' - ', and those factors whose influence was either positive or negative were coded with a ' * '.

Although the list of factors totalled 72 in all, 35 factors were found to be unique to specific studies and thus their frequency of occurrence was 1. The highest incidence of occurrence of any factor was 6 times in 19 studies for two factors (a well-planned R&D process and high-level management support).

Balachandra and Friar conclude that there is no one universal model encompassing all the success/ failure factors, rather that the impact of the factors is context based. Several important factors deemed significant for successful product innovation or R&D projects can vary not only in magnitude but also in direction depending upon context. It appears that a factor may be helpful in leading to success in some contexts but may lead to failure or be unimportant in a different context.

								S	T	U	D	Y	N	U	M	B	E	R						
No.	Factor	Type	1	2	3	7	8	9	14	15	17	Total R&D	4	5	6	10	11	12	13	16	18	19	Total NPD	Total
1	Availability of resources, Raw Materials	E		+	+			+	+			4											0	4
2	Government Regulations	E		*								1											0	1
3	Industry Restructure Opportunity	E							*			1											0	1
4	Political/ Social Factors	E			*				*			2											0	2
5	Public interest in product	E			*							1											0	1
6	Risk Distribution	E,M, T							+			1											0	1
7	Product Liability	E,T			-							1											0	1
8	Competitive Environment	M			+							1	*	*								*	3	4
9	Competitor Analysis	M							+			1											0	1
10	Early analysis of market & profit	M										0						-					1	1
11	Early to market	M										0					-						1	1
12	Few Competitors	M										0										+	1	1
13	High Contribution Margin	M	+								+	2					+						1	3
14	Life Cycle of product	M		*								1										+	1	2
15	Lower Cost	M			+					+	+	3		+									1	4
16	Market Analysis	M									*	1	+										1	2
17	Market Existence	M		+	+		+	+				4											0	4
18	Meets customer needs/wants	M				*						1								+			1	2
19	Number of end uses	M		-				+				2											0	2
20	Perceived value	M										0		+		+							2	2
21	Probability of commercial success	M		+		+						2											0	2
22	Rate of new product introduction	M		+				-				2											0	2
23	Response to growing markets	M									+	1											0	1
24	Sales/Profit potential	M							+		+	2											0	2
25	Slow growth market	M										0										-	1	1
26	Strength of market	M										0		+		+							2	2
27	Client acceptance	M,T								+		1											0	1
28	Commitment of project workers	O		+				+		+		3											0	3
29	Communication	O								+	+	2											0	2
30	Correct Distribution channels	O										0	+										1	1
31	Create, Make, Market interface	O									+	1					+	+					2	3
32	Demand for quick results	O			-						+	2											0	2
33	Effectiveness of project manager	O		+								1											0	1
34	Effects on other business	O			+							1											0	1
35	Emphasise marketing	O										0	+			+	+			+		+	5	5

36	Error Free production	O										0	+							+			2	2
37	High Level Management support	O	+	+	+			+		+		5					+						1	6
38	Inexpensive development	O										0							+				1	1
39	Internal competition	O		+								1											0	1
40	Management and other skills	O							+			1		+						+			2	3
41	Meeting Cost schedules	O		+								1	+										1	2
42	Markets and technologies are strengths	O										0		+		+	+				+		4	4
43	Monitoring and feedback	O								+		1											0	1
44	Newness to firm	O										0		*									1	1
45	Organisation plans	O			+							1											0	1
46	Potential interest of technical staff	O			+							1											0	1
47	Project mission	O								+		1											0	1
48	Project schedule	O								+		1											0	1
49	Project manager as project champion	O		+				+				2											0	2
50	Qualified project manager	O				+						1											0	1
51	Quantitative project selection	O										0						+					1	1
52	R&D process well planned	O	+	+							+	3			+		+				+		3	6
53	Source of project ides	O										0						+					1	1
54	Staff of professionals	O				+						1											0	1
55	Strong Sales force	O										0	+										1	1
56	Technology tied to business strategy	O										0			+		+				+		3	3
57	Technical background of managers	O										0			+								1	1
58	Timing	O			+		+				+	3	+										1	4
59	Training and experience of own people	O	+									1							+		+		2	3
60	Trouble shooting	O								+		1											0	1
61	Understanding market	O				*						1				+					+		2	3
62	Use outside communication	O										0								*			1	1
63	Demand pull v's Tech push	T									*	1						*	*				2	3
64	Directions for scientific development	T			+							1											0	1
65	High Performance to Cost	T									*	1				+	+						2	3
66	Incremental product	T										0							+				1	1
67	Innovative product	T										0		+		+							2	2
68	Patents	T			+							1											0	1
69	Problem Definition	T									*	1									+		1	2
70	Probability of technical success	T		+	+	+	+	+				5											0	5
71	Utility	T			*							1											0	1
72	Technology Route	T,O		+						+		2											0	2
	Total Number of Factors		4	16	16	7	3	8	7	10	13	84	8	8	3	6	9	6	4	5	6	5	60	144

Table 4.2: Factors identified by the studies.

4.2 Survey of Success Factors and Success Measures in the Acquisition of Manufacturing Technology - Introduction

In the fields of NPD and R&D, the success factor method has been used in many research studies and is a very well established methodology. However, no work has been identified which focused on success factors and success measures for Manufacturing Technology Acquisition.

It was decided to carry out a research enquiry into what factors contribute to success and failure in MTA and also how to measure success/ failure in these projects. The aim was to establish comprehensive lists of factors and measures for MTA.

The research methods employed have been reviewed in the Research Design and Methodology, chapter three, section 3.5. The initial interviews were conducted between December 1996 and April 1997 using the semi-structured interview technique. Sixteen interviews took place about projects in sixteen different manufacturing companies. Candidates were interviewed about a project in which they had been directly involved. No success factors or measures were suggested in advance by the interviewer, as the objective was that all of the factors (and any other relevant issues) should be derived empirically from the direct experience of the interviewees.

Each interview was transcribed and analysis conducted using Content Analysis (Chapter three, section 4.2). This resulted in a list of statements or extracts from which 75 success factors and 38 measures were developed for successfully in acquiring manufacturing technology.

In this section the research method is explained. The results are given in the next section, 4.3.

4.2.1 The Manufacturing Technology Acquisition Projects

The sixteen projects discussed during the interviews ranged from relatively low cost projects of around £50,000 up to major manufacturing investment projects with a cost of $65 million; the duration of the projects varied from 4 months to 6 years. A summary of the projects is given in Table 4.3.

Project No.	Industry	Project Description	Acquisition Type	Duration	Cost	Outcome
1	Textiles	Automated Folding machine	Joint Development	2 years	£300,000	Unsuccessful
2	Automotive	Minibus Roof Assembly System & equipment	Internal R&D	4 months	£50,000	Successful
3	Automotive	Airbag Manufacturing Machines	International Transfer	4 months	£5 million	Unsuccessful
4	Pharmaceutical	New process & equipment	Internal & Joint Development	1 year	£3 million	Successful
5	Aeronautical	MRP II & manufacturing process	Purchase from Supplier	1 year	£-	Unsuccessful
6	Food	New process & equipment	Collaborative with University	4 years	£50,000	Successful
7	Textiles	Automated Folding machine	Joint Development	2 years	£180,000	Successful
8	Clothing	Automated Sewing Technology	Off-the-shelf Purchase	12 months	£500,000	Unsuccessful
9	Chemical	Kevlar Manufacturing Technology	Joint Development	2 years	$65 million	Successful
10	Chemical	Automated Materials Handling System	Joint Development	2 years	£1.5 million	Unsuccessful
11	Medical Products	New Packaging equipment	Joint Development	18 months	£500,000	Successful
12	Clothing	Automated Sewing Technology	Off-the-shelf Purchase	3 years	£500,000	Successful
13	Textiles	Linen manufacturing equipment	Joint Development	10 months	£3 million	Successful
14	Textiles	Crease resistant Linen & process machinery	Joint Development	6 years	£50,000	Unsuccessful
15	Textiles	High Speed Loom machine	Joint Development	18 months	$3 million	Successful
16	Chemical	High Speed Rubber Loom	Joint Development	2 years+	$450,000	Unsuccessful

Table 4.3: Project Summary

4.2.2 Semi-Structured Interviews

Interviews were personal and confidential. All interviews were tape-recorded to facilitate transcription and Content Analysis. Interviewees were sent a letter in advance briefing them on the format of the interview and notifying the interview agenda, which included:

- Respondent's and Company's background
- One successful or one unsuccessful project that you have personal experience of
- How well these projects proceeded
- What went right and what went wrong
- Parties involved in the project
- Appraisal of project outcomes
- Other issues

An example of the briefing letter is given in Appendix D (i).

4.2.3 Model for Framing Interviews

A model was developed by the researcher to aid in the actual interview process. This model gave an overview of a range of options and components parts of a typical process for acquiring manufacturing technology. It helped the interviewer ensure that many of the issues associated with acquiring manufacturing technology were covered during the interview sessions. It also was sufficiently broad in scope to allow other more general aspects of technology management to be explored. The model is illustrated in figure 4.1.

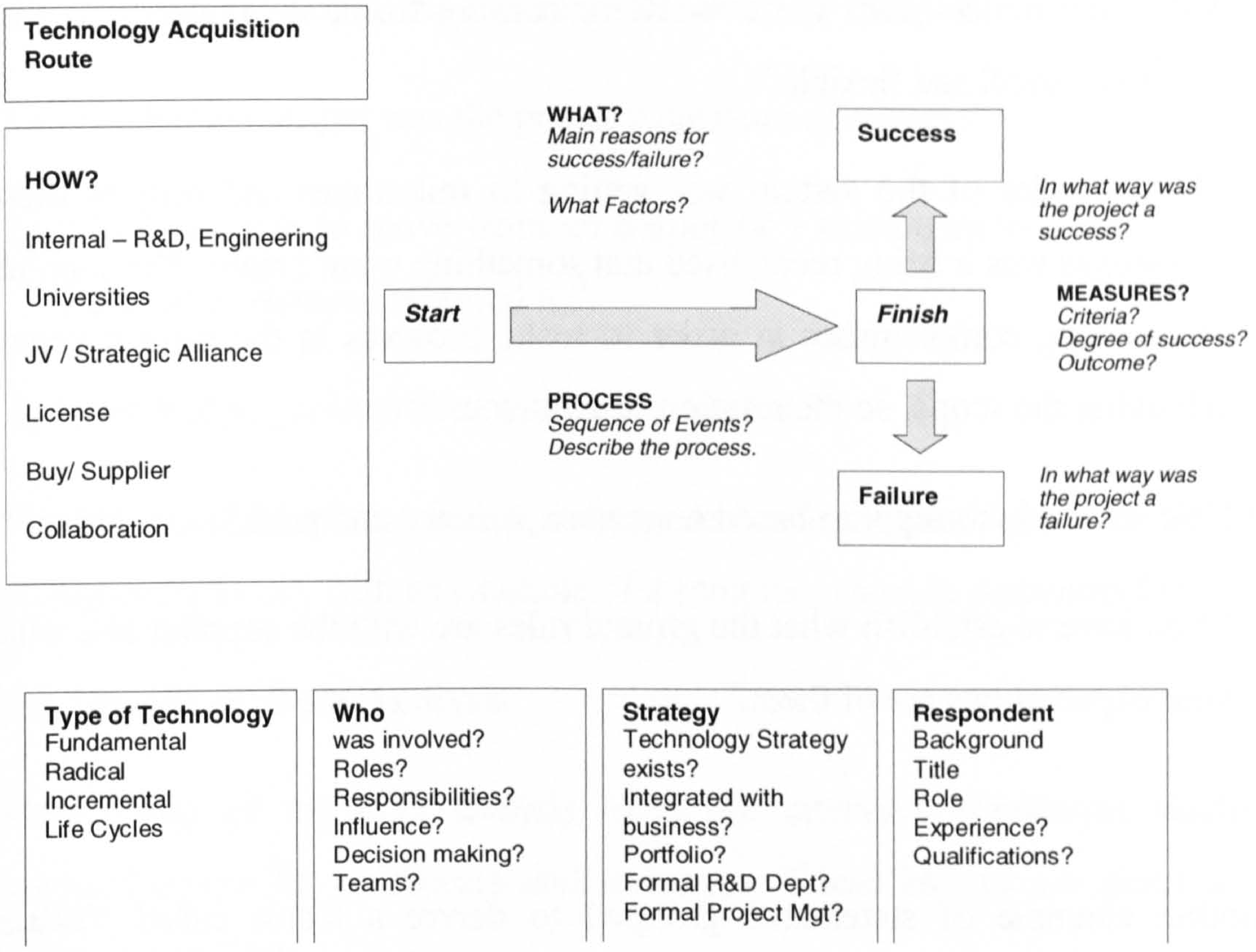

Figure 4.1: Model for framing interviews

4.2.4 Content Analysis

Content analysis has been discussed in chapter three. In applying this process to the transcribed interviews, statements in relation to factors or measures were grouped into factor or measure headings devised by the researcher. Similar statements were grouped into one heading which was either a factor or a measure. For example, the following three statements from the interviews were grouped to yield a factor called "**Supplier Relationship**":

1.) "We had a good relationship with the machine supplier we were working with; they understood where we were coming from, we understood that they were small and flexible."

2.) "The supplier of the system was getting to milestones and only at these milestones was it being recognised that something wasn't right. The supplier was making compromises in order to make progress in the project versus achieving the scope, so the relationship got sour."

3.) "We selected the supplier based on past experience and price"

4.) "You have to establish what the ground rules are with the supplier and what your expectations are of them."

Another example of statements grouped to derive a factor called "**Team Selection**" was:

1.) "When putting teams together, we spent a lot of time looking for the right people for the team; we worked on the different disciplines that a team needs."

2.) "The key guy was the engineering manager; He was the brains behind the whole thing, coming up with the designs."

3.) "We brought in a new management team"

4.) "Making certain the right team members were in place, selecting the appropriate people to do the job."

5.) "He was not the right person for the job {the engineer}; he didn't really understand project management and the technology he was getting."

The same approach was used to derive the list of measures. An example of statements in relation to the measure "**Production Output**" was:

1.) "Production output was the primary measure of success"

2.) "We were able to move from an output of 7 minibuses to 9 minibuses per week when demand required it."

3.) " We had to get improved production output."

Further examples of statements used to derive factors and measures are given in Appendix D (ii), with an example of a summary sheet in Appendix D (iii).

4.3 Results of Data Analysis

Completion of the data analysis from the interview transcripts yielded a comprehensive list of factors and measures. These listings are given in the following sections.

4.3.1 Success Factors and Measures

Analyses of the interviews using Content Analysis, involving much checking and rechecking, yielded 75 factors for success/ failure and 38 measures. As the interviews progressed, the number of new factors and measures being discovered decreased as many had already been mentioned in previous interviews. This led to the belief that the "completeness" of the listings developed was robust. The 75 factors were grouped into 9 broader logical categories to assist in the analysis, and for presentation. Likewise, the list of measures was also grouped into 7 broad categories. The list of factors is shown in Table 4.4, and the list of measures in Table 4.5.

No.	Category	Factor
1	ORGANISATIONAL	Need
2		Clearly defined objectives
3		Objectives understood
4		Strategic aspect
5		Vision
6		Org/Dept structure
7		Internal competition
8		Environment / Change
9		Communication
10	ANALYTICAL	Proper analysis
11		Sufficient evaluation
12		Competitor analysis
13		Statistical analysis
14		Background analysis
15		Identify constraints
16		Documentation
17		Format of information
18		Customer needs / wants - survey
19	TECHNICAL	Design
20		Specification
21		Define functionality
22		Fit for purpose / application
23		Equipment age
24		Reliability
25		Sufficient Development
26		Computer controlled
27		Ease of re-set
28		Ease of maintenance
29		Set-up time
30		Understand technologies / science
31		Know technologies available / selection
32		Upgradable
33		Complexity
34	MANAGEMENT	System
35		Planning
36		Top management support
37		Team composition
38		Team cohesion
39		Team balance
40		Implementors
41		Sufficient time
42		On time
43		Knowledge of procedures
44		Hard work / long hours
45		Skill of project manager
46		Know people involved
47		Structured project management
48		Cross functional teams / integrated
49		Financial support
50		Control
51		Review
52		Project owner / champion
53		Human resources available
54	HUMAN	Level of knowledge
55		Experience
56		Drive / motivation
57		Level of conviction / commitment
58		Perceptions
59		Negotiation skills
60	OPERATIONAL	On-going production not affected

61		Trial run / pilot
62		Preventative Maintenance Programme
63		Slow build-up / ramp-up
64	SUPPLIER	Supplier selection
65		Narrow down suppliers
66		Confidence in suppliers
67		Supplier relationships
68		Support
69		Frequency of contact
70		Co-ordination of Suppliers
71	LEGAL	Patenting
72		Patent Attorney skills
73	EXTERNAL ENVIRONMENT	Sales Levels
74		Miscellaneous Events
75		State of Industry

Table 4.4: List of success/ failure factors in MTA, found by content analysis of the interviews.

No.	Category	Measure
1	**MANUFACTURING**	Production output
2	**PERFORMANCE**	Quality
3	**PARAMETERS**	Downtime /uptime/reliability
4		Amount of maintenance
5		Efficiency /performance/utilistion
6		Scrap/waste
7		Frequency of problems
8		Functionality
9		Throughput
10		Set-up/changeover times
11		Capacity
12	**OPERATIONAL**	Plant space
13		Ergonomic benefits
14		Training times
15		De-skill operations
16		Flexibility
17		Ease of implementation
18		Capability
19	**MANAGEMENT**	Management information
20		Management control
21		Data integrity
22	**TIME**	Time taken
23		Schedule - start & finish on time
24	**ECONOMIC / FINANCIAL**	Operating costs
25		Cost - capital + other
26		Savings - labour / material
27		Within budget
28		Return on investment /payback
29		Profitability
30		Patent revenue
31	**BUSINESS**	Business objectives / strategy
32		Meeting customer needs
33		Additional / new business
34		Customer Returns (RTM's)
35		Marketing
36		Supply chain integration
37		New product derived
38	**EXTERNAL**	Compliance with regulatory bodies

Table 4.5: List of success/ failure measures in MTA, found by content analysis of the interviews.

4.3.2 Discussion - Distribution Analysis of Factors and Measures

The factors were further analysed using a distribution analysis[1] as shown in Table 4.6. The lighter colours indicate factors that contributed to the projects failing, whilst the darker coloured cell indicates that the factor contributed to a successful project outcome.

	Factors			**Interview Number**																
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	15	16			
	Successful / Unsuccessful ->	*u*	*s*	*u*	*s*	*u*	*s*	*s*	*u*	*s*	*u*	*s*	*s*	*s*	*u*	s	u			*f*
Organisational	Need						■					■								2
	Clearly defined objectives	1	■				■		1		1									5
	Objectives understood		■							■	1									3
	Strategic aspect					1														1
	Vision									■										1
	Org/Dept structure								1											1
	Internal competition									■										1
	Environment / Change													■			1			2
	Communication									■						■	1			3
Analytical	Proper analysis	1					■													2
	Sufficient evaluation			1																1
	Competitor analysis		■																	1
	Statistical analysis						■													1
	Background analysis						■													1
	Identify constraints						■							■						2
	Documentation								1	■										2
	Format of information								1											1
	Customer needs/ wants survey									■	1									2
Technical	Design	1		1				■			1	■				■				6
	Specification	1		1	■										1					4
	Define functionality									■	1									2
	Fit for purpose / application			1					1											2
	Equipment age			1																1
	Reliability	1																		1
	Sufficient Development	1																		1
	Computer controlled			1												■				2
	Ease of re-set			1					1											2
	Ease of maintenance			1																1
	Set-up time								1											1
	Understand technologies/science									■										1
	Know technologies available/selection							■								■				2
	Upgradable												■							1
	Complexity																1			1
Management	System							■	1											2
	Planning	1	■				■			■										4
	Top management support					1		■												2
	Team composition				■			■		■	1			■		■				6
	Team cohesion	1																		1
	Team balance									■										1

---

[1] Distribution Analysis is the term the author has used to describe the matrix displays of factors and measures in Tables 4.6 and 4.8, as they give a visual representation of both the spread of data and the frequency of occurrence.

	Implementors									■										1
	Sufficient time	1																		1
	On time						■		1		1									3
	Knowledge of procedures				■						1									2
	Hard work / long hours						■													1
	Skill of project manager						■									■				2
	Know people involved						■	■												2
	Structured project management							■	1											2
	Cross functional teams / integrated							■		■										2
	Financial support							■												1
	Control								1						1					2
	Review	1								■				■						3
	Project owner / champion											■								1
	Human resources available								1				■							2
Human	Level of knowledge				■						1			■		■				4
	Experience				■				1							■				3
	Drive / motivation					1		■	1								1			4
	Level of conviction / commitment	1														■	1			3
	Perceptions			1		1						■								3
	Negotiation skills						■													1
Operational	On-going production not affected						■					■								2
	Trial run / pilot							■												1
	Preventative Maintenance Programme												■							1
	Slow build-up / ramp-up												■							1
Supplier	Supplier selection							■												1
	Narrow down							■												1
	Confidence in Suppliers							■												1
	Supplier relationships							■			1									2
	Support			1					1						1					3
	Frequency of contact										1									1
	Co-ordination of Suppliers													■						1
Legal	Patenting						■													1
	Patent Attorney skills						■													1
External	Sales Levels			1																1
Environment	Misc Events						■													1
	State of Industry								1											1
																		Tot	Avg	139
	75	11	4	11	5	4	16	15	16	14	11	5	4	6	3	9	5	139	8.7	

Table 4.6: Distribution Analysis of Factors with lighter colours indicating factors that contributed to failure, whilst the darker coloured cells indicate factors that contributed to the project being successful.

As can be seen from the above analysis, a total of 139 factors in total were extracted from the interviews of all 16 projects discussed, giving an average of 8.7 factors per project. The highest number of factors derived from any single project was 16, and the lowest 3.

The highest frequency of occurrence of any single factor for all 16 projects was 6, with many factors appearing only once and thus being unique to that specific project. Table 4.7 summarises the frequency of occurrence of the factors:

The factors "Design" in the technical category and "Team Composition" in the technical category had the two highest occurrences in the 16 projects. These were followed by "Clearly defined objectives" which occurred 5 times.

No.of Occurrences	**6**	**5**	**4**	**3**	**2**	**1**
No.of Factors	**2**	**1**	**4**	**8**	**22**	**38**
% of Factors	**2.7%**	**1.3%**	**5.3%**	**10.7%**	**29.3%**	**50.7%**

Table 4.7: Frequency of Occurrence of Factors

As can be seen in Table 4.7, 50.7% of the factors are unique to a single project. This is similar to the findings of Balachandra and Friar (1997) where 50% of their 72 factors were specific to a single study.

Another significant observation from the distribution analysis of factors in Table 4.6 is the high concentration of factors for failed projects found within the technical category. Of the 28 times technical factors occurred, 18 times (64%) were in relation to factors causing failure in the projects. When adjusted for the ratio of successful/ failed projects reviewed, this number increases to over 70%.

A distribution analysis of measures used in the sixteen projects is given in Table 4.8. The lighter coloured cells indicate the measures used in projects that were unsuccessful and the darker coloured cells indicates measures used in projects that succeeded.

	Measures			**Interview Number**																
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	15	16			*f*
	Successful / Unsuccessful ->	*u*	*s*	*u*	*s*	*u*	*s*	*s*	*u*	*s*	*u*	*s*	*s*	*s*	*u*	s	u			
Manufacturing	Production output	1	■	1	■				1	■			■			■				8
Performance	Quality	1		1	■				1	■		■	■				1			8
Parameters	Downtime /uptime/reliability	1			■			■			1	■	■			■	1			8
	Amount of maintenance			1																1
	Efficiency /performance/utilistion					1			1	■			■			■				5
	Scrap/waste		■													■	1			3
	Frequency of problems							■												1
	Functionality									■	1									2
	Throughput											■								1
	Set-up/changeover times			1							1	■		■						4
	Capacity															■				1
Operational	Plant space							■												1
	Ergonomic benefits							■												1
	Training times							■												1
	Deskill operations												■							1
	Flexibility							■						■						2
	Ease of implementation								1			■								2
	Capability													■						1
Management	Management information					1														1
	Management control					1									1					2
	Data integrity								1											1
Time	Time taken								1		1		■							3
	Schedule - start & finish on time									■										1
Economic	Operating costs								1											1
	Cost - capital + other	1							1	■										3
	Savings - labour / material		■					■					■			■	1			5
	Within budget			1						■										2
	Return on investment /payback			1			■	■				■				■				5
	Profitability				■									■						2
	Patent revenue						■								1					2
Business	Business objectives / strategy				■				1	■	1									4
	Meeting customer needs				■		■							■						3
	Additional / new business				■															1
	Customer Returns (RTM's)							■												1
	Marketing							■												1
	Supply chain integration									■										1
	New product derived														1					1
External	Compliance with regulatory bodies				■		■													2
																				93
																		Tot	Avg	
	38	4	3	6	8	3	4	10	9	9	5	6	7	5	3	7	4	93	5.8	

Table 4.8: Distribution Analysis of Measures

This distribution analysis of success measures shows that 93 measures were extracted from the interviews on 16 projects, yielding 38 measures in total. There was an average of 5.8 measures per project, with a range from a low of 3 to a high of 10 stated in any single project.

Again, similar to the distribution for factors, many measures (47.4%) occurred on only one occasion. However, 3 measures (7.9%) had 8 occurrences in 16 projects (50%). These measures were the standard manufacturing performance measures of:

- Production Output
- Quality
- Downtime

The frequency distribution of the 38 measures is shown in Table 4.9.

No.of Occurrences	8	7	6	5	4	3	2	1
No.of Measures	3	0	0	3	2	4	8	18
% of Measures	7.9%	0%	0%	7.9%	5.3%	10.5%	21.1%	47.3%

Table 4.9: Frequency of Occurrence of Measures

Analysis of the measures also shows a clustering or concentration of measures categorised as "Manufacturing Performance Parameters." These accounted for 45% of all occurrences extracted from the projects' data and for 11 of the 38 measures (29%).

The measures within the "Economic/Financial" category totalled 7 (18% of the 38 measures) and included measures such as return on investment, profitability, labour savings, etc. They were mentioned as a success measure in 65% of the projects reviewed.

A particularly noteworthy point is that during the interviews, many respondents stated that they had not previously considered what was meant by success or success measures in relation to a manufacturing technology acquisition project, even though they were used to quantifying outcomes like return on investment or payback.

4.4 Comparison of Factors from the Survey with those found in the Literature.

The list of 72 factors found by Balachandra and Friar (1997) in the field of R&D and NPD was compared to the list of factors derived for MTA. Although the fields of R&D and NPD are quite different from MTA, some common factors were expected.

A listing of factors found to be common to both is given in Table 4.10.

	Balanchandra & Friars' Factors	F/M	*f*	Study Factor / Measure	F/M	*f*
1	Availability of resources, raw materials	F	4	Human resources available	F	2
				Financial support	F	1
2	Competitor analysis	F	1	Competitor analysis	F	1
3	Early analysis of market & profit	F	1	Proper analysis	F	2
				Background analysis	F	1
				Profitability	M	2
4	Lower cost	F	4	Cost – capital & others	M	3
5	Market analysis	F	2	Marketing	M	1
6	Meets customer needs/wants	F	2	Meets customer needs	M	3
				Customer needs/wants - survey	F	2
7	Perceived value	F	2	Perceptions	F	3
8	Sales/profit potential	F	2	Profitability	M	2
				Additional sales/new business	M	1
9	Commitment of project workers	F	3	Level of conviction/commitment	F	3
				Drive/motivation	F	4
10	Communication	F	2	Communication	F	3
11	Effectiveness of project manager	F	1	Skill of project manager	F	2
12	High level management support	F	6	Top management support	F	2
13	Meeting cost schedules	F	2	Operating cost	M	1
				Cost – capital and other	M	3
14	Monitoring & Feedback	F	1	Review	F	3
15	Project mission	F	1	Vision	F	1
				Clearly defined objectives	F	5
16	Project schedule	F	1	Planning	F	4
15	Project manager as project champion	F	2	Project owner/champion	F	1
16	Qualified project manager	F	1	Skill of project manager	F	2
17	R&D process well planned	F	6	Planning	F	4
				Structure project management	F	2
18	Technology tied to business strategy	F	3	Strategy	F	1
				Business strategy	M	4
19	Timing	F	4	On time	F	3
				Time taken	M	3
20	Training and experience of own people	F	3	Experience	F	3
21	High performance to cost	F	3	Efficiency/performance	M	5
				Cost – capital & other	M	3
22	Innovative product	F	2	New product derived	M	1
23	Patents	F	1	Patenting	F	1
24	Probability of technical success	F	5	Technical	Cat	X

Table 4.10: Comparison of Balanchandra and Friars' list of Factors with those derived from the author's survey, showing factors that were common to both studies. 'F' denotes a factor and 'M' denotes a measure.

In some cases, the factor names vary from Balachandra and Friars' review when compared to factor names presented by the researcher. As far as possible, the factors from the literature have been matched to those of the MTA studies but there is a degree of interpretation involved as definitions of the factors are not given in the literature. In fact, as is explained in Research Results and

Conclusion (chapter nine), this is one of the major weaknesses of both this research and the existing literature on success factor studies.

As can be seen in Table 4.10, many of the factors found in the literature on success factor in NPD and R&D are also present in the studies of MTA. One third (24/ 72) of the factors found to be significant by Balachandra and Friar were also present in the MTA projects studied. For example, factor number 2, “competitor analysis”, is a common factor and has a frequency of occurrence of one in both sets of studies.

Another interesting observation is that many of the factors in Balachandra and Friars’ listing are actually stated and categorised as being measures in the researcher’s findings. For example, the factor “sales/ profit” is actually a measure of success in the MTA studies, rather than a causal factor of success or failure.

Also noteworthy is that 75% of Balachandra and Friars’ factors that were common to the MTA factors had a frequency of greater than one, whereas in their total listing only 50% of their factors occurred more than once.

4.4.1 Discussion: Numbers of Factors found

During the interviews it was apparent that key players in MTA projects could only recall a limited number of factors that contributed to the success or failure of a project, with an average of 8.7 factors being cited. Balachandra and Friar’s studies (1997) yielded an average of 8.1 factors per research paper. However, the factors’ list is comprised of 75 factors in the case of MTA projects and 72 in their study. In both cases (R&D/ NPD and MTA) it may be conjectured that there may be a large number of factors present during a project but only some were remembered afterwards, possibly only these were key to success or failure in a given project.

4.4.2 Use of these Findings as a Checklist

To assist the practitioner in carrying out MTA projects, it was believed that the development of a checklist of factors as given in Table 4.4 would be useful. This checklist could be operationalised by turning the checklist of factors into questions to be asked at various stages in the project. For example, during the project selection phase, the following questions could be asked based upon the factor “need” in the Organisation Category:

- Why is this project needed?
- When was the need identified?
- Who determined the need for this project?

During the execution phase when the project is actually underway, the following Technical category questions could be asked:

- Is the machine fit for purpose/
- How good is the design for task required?
- How old is the technology?
- How reliable is the technology?
- What are the main design weaknesses?
- How long is the set-up time?
- Who understands the technology being used?
- How complex is the technology?

These examples illustrate that an extensive list of questions could be developed from the checklist of factors and that these may assist the practitioner to get a better understanding of what is actually happening during an MTA project. The checklist provides the opportunity to ask critical questions from the concept generation stage right through to project completion.

Likewise, the list of measures could be operationalised in a similar way:

- What is the downtime on the machine for the last week?
- What level of defects is the equipment producing?
- How long is the operator training time on the machine?
- How much maintenance is required?
- What is the capacity of the machine?
- What return on investment can be expected?
- How much scrap is generated with this technology?

As is evident from the above sample of questions, this list too could be extended to ask questions and collect the necessary data to evaluate the outcome of the acquisition.

The Checklist of factors and measures can provide the practitioner with an additional tool for evaluating the manufacturing technology over a project lifecycle.

4.5 Discussion

It was found from the interviews that 9 projects were successful and 7 projects were failures, which somewhat contradicts the literature as Balachandra and Friar (1997) found that very few studies dealt with failed projects with the assumption that:

> *"There were more cases of success in the samples even though in actuality, there are more failures than successes. Researchers indicate that it is difficult to get data about failures. Some researchers say that they are fortunate to get even as many examples of failed projects as they have."*

The fact that there is a relatively even balance of successful and failed projects may be because the interviewees were requested in advance to consider both types of projects for the interviews. It was evident from the projects discussed with key players in MTA in other companies that these failures can often be major project failures. For example, in one of the cases, involving the setting up of a complete new production line for manufacturing airbags for use in the automotive industry, the entire £5 million project failed and the new technology was scrapped. In this project, 11 factors were stated as contributing to failure and 7 of the factors were in the technical category.

Most of the literature on the causes of project success and failure demonstrates that the relative importance of any of the factors are often contingent on specific project characteristics, such as type of project and its stage in the project lifecycle (Pinto and Mantel, 1990). The author's findings support this view as 50% of the factors in the sixteen MTA projects were found to be unique to a specific study.

The comprehensive list of factors and measures can be used to improve the chances of success in MTA projects. This theme is developed further in chapter nine.

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Chapter 5

Portfolio Management and R&D Project Selection Techniques.

5.0 Introduction

This chapter examines the potential to use Portfolio Management in the area of manufacturing technology acquisition. The first section gives a brief introduction to the evolution of portfolio management theory, followed by a review of other R&D project selection methods. Next, Third Generation R&D Portfolio methods (Roussel *et al*, 1991) and portfolio management for new products (Cooper *et al*, 1998) are discussed. Finally the application of portfolio techniques to the field of MTA is discussed. Chapter six reports the development and testing of new portfolio constructs for MTA in the researcher's factories.

The term portfolio originated as meaning a lawyer's collection of current case documents (folios) – which would be carried about in a case called a portfolio. The term was then adopted to describe a collection of investments. Someone's investment portfolio might be selected to spread risks and to balance short, medium and long-term investments in line with the needs the investments were intended to meet. Extending the term further, a company could have a portfolio of business projects and its R&D department a portfolio of NPD projects on hand.

The concept of business portfolios and their use in optimizing strategic business decisions originated in the 1960s. By the 1970s their use was relatively widespread and indeed they had developed into a powerful strategic planning tool. As strategic planning theory and practice have developed, most firms have come to recognise two types of strategy: business unit strategy and corporate strategy (Porter, 1985). Business unit strategy charts the course for a firm's activities in individual industries, while corporate strategy addresses the composition of a firm's portfolio of business units. Reflecting this distinction, most major firms have divided their businesses into some type of strategic business units (SBUs), and instituted formal planning processes in which SBUs submit plans for review by top management. At the same time, corporate strategy has become increasingly viewed as portfolio management in itself, typically using some variation of portfolio planning techniques that were widely adopted in the 1970s (Haspeslagh, 1982).

5.1 Portfolio Management for New Products

Portfolio management in NPD should decide which of all proposed project ideas should be funded by the company in the hope of producing a suitable range of successful new products. The use of portfolio management techniques extended to the field of new product development during the 1970s and has appeared under the titles of R&D project selection, R&D resource allocation, project prioritisation and portfolio management. The majority of these early techniques used a group of mathematical optimisation methods collectively known as Management Science. To the management scientist, the challenge of portfolio management was one of constrained optimisation under conditions of uncertainty: a multi-project, multi-stage decision model solved by mathematical programming. Thus, the objective of these early models was to develop a portfolio of new and existing projects to maximise some objective function subject to a set of resource constraints.

Attempts to apply management science techniques to product development portfolio analysis in a real-world setting were limited. Cooper *et al,* (1998), stated that:

> *"Anyone familiar with these programming techniques will immediately recognise the hurdles that the mathematician and management scientist would have solving this portfolio problem. Further, in spite of the many methods proposed in the early days, there was a remarkable lack of follow-up: for example, few authors ever described attempts to actually implement their methods and to gauge their feasibility; indeed, the articles appear to be largely the results of academics writing to and for each other. In spite of the importance of the topic, no guru or dominant school of thought ever emerged here, perhaps an indication of the frustration faced in seeking solutions".*

This view is supported by the work of Archer and Ghasemzadeh (1996), Baker (1974) and Danila (1989).

However, the use of R&D portfolio management in companies is on the increase and its widespread application throughout industry is predicted. Indeed, Roussel, Saad and Erickson in their book, Third Generation R&D (1991) predicted:

> *"R&D portfolio analysis and planning will grow in the 1990's to become the powerful tool that business portfolio planning became in the 1970's and 1980's".*

Anecdotal evidence is that this has happened. Before describing NPD portfolio management in detail, other techniques will be briefly reviewed.

5.2 Other R&D Project Evaluation Methodologies

Before Portfolio methods can be explained, it is necessary to review a variety of other methods, which are used instead of, or as part of portfolio methods and which have developed over the same period of time. The use of these methods has not been restricted solely to new product evaluation, but has been extended to general R&D project selection (new products and processes), capital investment appraisal and investment decisions in Advanced Manufacturing Technology (AMT). These methods will now be described.

5.2.1 Classical Methods

The project justification methodologies in this category employ a single economic objective to justify investment in new products. These traditional financial methods include Net Present Value (NPV), Internal Rate of Return (IRR), Cost/ Benefit (C/ B), Payback Period, Mathematical Programming, and Minimal Annual Revenue Requirement (MARR). They also include certain optimisation methods such as Sensitivity Analysis, Decision Trees, and Monte Carlo simulation (Karwowski and Salvendy, 1994).

5.2.1(a) Net Present Value (NPV)

The net present value is the sum of the net cash flows discounted at the minimum acceptable rate of return, to the present time or time zero (Stevens, 1989). The benefits of investment in new product development are generally realised over a long period of time. This has the effect that when a high hurdle rate (discount rate) and short recovery period are used in the analysis to compute the NPV, projects can often be rejected based on financial measures. Therefore careful consideration must be given to parameters used in calculating NPV. The net present value can be calculated using the following formula:

$$\text{NPV} = \sum_{j=0}^{n} \frac{Xj}{(1+k)}$$

where NPV is the net present value, X_j is the net cash flow in year j, n is the number of years of cash flow, and k is a rate of return set by the company.

5.2.1(b) Internal Rate of Return (IRR)

The interest rate which makes the sum of the discounted cash flows equal to zero is called the internal rate of return. Investment in a project is considered to be economically acceptable if the internal rate of return is greater than, or equal to, a selected hurdle rate or minimum attractive rate of return (MARR). It is expressed by the following formula:

$$\text{IRR} = \sum_{j=0}^{n} \frac{Xj}{(1+i)^j} = 0$$

Where Xj is the net cash flow in year j, n is the number of years of cash flow, and i is the internal rate of return. i is found by substituting trial values into this formula iteratively. The IRR is designed as an objective measure of the rate of return actually earned by a project and may therefore be used as a device for comparing the merits of a series of competing projects (Batty, 1976).

5.2.1(c) Payback Period (PBR)

The simplicity of this analysis tool has helped to ensure that it is the most prevalent method used by businesses to select.which new product development projects or R&D projects should be supported. It is also the main method covered in finance books for technology investment decision, primarily capital investment projects (including MTA). The payback period is the time required to recover the initial investment or, in other words, the time to balance the incoming cash flows and cash outflows. A project is considered acceptable if the payback period is equal to, or less than a predetermined payback period. It can be determined from the following equation:

$$\text{PBR} = \sum_{j=0}^{p} Xj = 0$$

Where *p* is the payback period and *Xj* is the net cash flow in year *j*. Limitations of this method include the absence of due consideration to both the time value of money and to assessment of the risks normally associated with new product development. This method requires the preparation of a cashflow forecast over time (Batty, 1976).

The great weakness in all of the financial methods is that they need a prediction of future project revenues, something which experience shows is largely uncertain, especially in the earliest stages of R&D work.

5.2.1(d) Mathematical Programming

This approach uses a mathematical programming formulation to select a subset of projects for investment from a given set of proposed projects. The objective function is to maximise the net present value of the projects subject to various constraints including labour availability and budgetary limitations. A drawback of this method is that the discount rate must be estimated by an analyst under an assumption of perfect and complete markets (Reeve and Sullivan, 1988).

5.2.1(e) Sensitivity Analysis

In the economic evaluation of investments in new product development, decision-makers must take into account the associated risks inherent in the new product development process. Often, sensitivity analysis is the means by which risk is brought into the equation. This can, for example, take the form of a percentage adjustment to the net present value. Tabular or graphical templates can be developed to assist in the assessment and application of the risk factor. Sensitivity analysis allows the significance of each variable to be examined independently. For instance, the expected completion date of a particular R&D project may be varied, whilst holding the other variables constant, to see the effect, if any, upon the overall profitability of that proposal (Batty, 1976).

5.2.1(f) Decision Trees

The drafting of a decision tree is a diagrammatic procedure useful in modelling complicated problems involving risk, sequential decisions, and outcomes. The decision tree type analysis is appropriate for situations where several similar decisions are being analysed over a period of time. For example, an initial decision is made to start a project that has a number of stages. The first stage may have two or more alternative outcomes, and depending on the outcome of the first stage, another decision must be made which moves the project on to the next stage. This in turn leads to another decision and another stage, and so on and so forth, until the final point is reached, such as the end of the project. The possible outcomes at each stage must have a probability associated with it, and decisions and probabilities are displayed as a decision tree (Martino, 1995).

5.2.1(g) Monte Carlo Simulation

This technique is used to analyse projects involving risk. An outcome for each variable of interest (element) is randomly selected from a probability distribution assumed to represent each criterion of interest, and these outcomes are then combined. A certain number of trials are then conducted and the combined outcomes are checked for some prescribed degree of accuracy. The important requirement of the technique is that the outcomes of all variables of interest be randomly selected (Sullivan and Orr, 1982).

5.2.2 Multicriterion Methods

The decision to invest in R&D projects frequently involves multiple and often conflicting objectives, for example, minimising costs and maximising return on investment. The decision-maker has to consider a number of criteria so that the most important criterion is satisfied first. Many multicriterion techniques have been developed and applied to the problem of deciding which R&D projects to fund. Some of the deterministic methods for solving multicriterion problems include mathematical programming, scoring models, the Analytical Hierarchy Process (AHP), and goal programming.

5.2.2(a) Multicriterion 0-1 Integer Programming

This is a simple approach to modelling and solving the problem of selecting the best project from a given set of projects. Given a set of projects $X = \{x_1, x_2, \ldots \ldots, x_n\}$ where $x_i = 1$, if the *i*th project is selected, and $x_i = 0$ otherwise. It is assumed that the minimum acceptable values of each attribute, such as NPV, payback period, competitive advantage and so forth, are known and available. If qualitative factors are considered in the problem, a weight on a scale from 0 to 1 is used for each factor. The values of each of these attributes for each project form the coefficients of the decision variables in the constraints and the objective function of the model. An example of the integer goal programming technique can be found in Taylor *et al* (1982).

5.2.2(b) Goal Programming

Goal programming can be used to model investment decisions from a multi-objective context. This mathematical programming tool features the ability to analyse multiple conflicting goals at both a strategic and tactical level. At the longer term strategic level, the company decides what type of technology it wants to develop and at a more short term tactical level it determines the range of alternatives available in order to attain that goal (Karwowski and Salvendy, 1994).

5.2.2(c) Scoring Models

Scoring models feature an attempt to accommodate intangible or economically non-quantifiable elements involved in an investment decision in an analytical fashion. Input data for scoring models are subjective estimates rather than hard factual data and ratings are taken from a numeric range (for example, 0-1, or 1-10) for each objective function under consideration. Factors are combined according to some formula into a single score, or some figure of merit. Projects are rated and scored on a variety of qualitative questions and in many cases the score becomes the criterion for project prioritization.

Scoring models capture multiple goals, such as strategic importance, competitive advantage, and market attractiveness (Cooper *et al*, 1998).

5.2.2(d) Analytical Hierarchy Process (AHP)

The analytical hierarchy process developed by Saaty (1980) allows decision makers to visually structure a complex problem in the form of a hierarchy having at least two levels: objectives (criteria for evaluation) and activities (products, courses of action, etc.). Each factor or alternative on a given level can be identified and evaluated with respect to other related factors.

The method centres on determining weights or priorities of a set of criteria in one level of the problem hierarchy to the level just above. By repeating this process level by level, the matrices summarising the priorities between levels can be multiplied to determine the priorities of the alternatives at the lowest level according to their influence on the overall goal or focus of the hierarchy (Liberatore, 1987).

5.3 Success of these Evaluation Methodologies

A recent benchmarking study pointed to project selection and project prioritization as the weakest facet of all new product activities (Cooper and Kleinschmidt, 1996). While the published literature over the past thirty years outlines many approaches for portfolio management and project selection, there is very little evidence regarding the actual transfer of these techniques into management practice (Cooper *et al*, 1998).

Just some of the objections by practicing managers include fundamental inadequacies in data representation and the lack of explicit recognition and incorporation of experience and knowledge, as well as non-monetary aspects. In many instances, managers fail to understand the underlying theory, and hence are prone to interpret the methods as inaccurate, misleading, or overly simplistic.

Throughout industry, "peer review" dominates practical programme evaluation, i.e. it is the experience and gut feeling of management, with input from the R&D team, that decides which projects are to be funded and at what levels (Bard *et al*, 1988). When models are used to provide guidance, they commonly cover only the allocation of resources at the initial stages and assume that all projects have a high probability of success (Tymon and Lovelace, 1986). For example, Payback Period and Discounted Cash Flow techniques are both well known but even so, they are not universally used. Thus there remains a major gulf between theory and practice.

The case study in chapter six attempts to bridge this gap between theory and practice and test out the validity and effectiveness of portfolio management techniques in the researcher's own organisation over a number of annual cycles, but in a new field of application, that of MTA.

5.4 Description of Portfolio Management

Cooper *et al* (1998) describe portfolio management as:

> *"a dynamic decision process, whereby a business's list of active new product (and R&D) projects is constantly updated and revised. In this process, new projects are evaluated, selected and prioritized; existing projects may be accelerated, killed or de-prioritized; and resources are allocated and reallocated to the active projects. The portfolio decision process is characterized by uncertain and changing information, dynamic opportunities, multiple goals and strategic considerations, interdependence among projects, and multiple decision-makers and locations. The portfolio decision process encompasses or overlaps a number of decision-making processes within the business, including periodic reviews of the total portfolio of all projects (looking at all projects holistically, and against each other), making Go/Kill decisions on individual projects on an ongoing basis, and developing a new product strategy for the business, complete with strategic resource allocation decisions ".*

There follows a brief review of the complex topic of portfolio management. Excellent full accounts will be found in *Third Generation R&D* (Roussel, Saad and Erickson, 1991) and *Portfolio Management for New Products* (Cooper, Edgett and Kleinschmidt, 1998).

5.5 Third Generation R&D Approach to Portfolio Management

To build up the R&D portfolio, business managers and R&D managers first examine each proposed or active individual project, then place each project within portfolio structures that accommodate the strategic elements most critical to the specific business unit and its industry. Individual projects are evaluated in terms of four key elements (Roussel *et al*, 1991):

(1) Technological competitive strength (i.e. how strong in R&D is a company compared with competitors believed to be pursuing the same objectives?).

(2) Technological maturity (i.e. how much possibility of technical advance remains in the key or pacing technologies embodied in the R&D projects?).

(3) Competitive impact of technologies (where the technology is in its lifecycle - base, key, pacing, embryonic)

(4) R&D project attractiveness (business strategy fit, reward, risk, etc.).

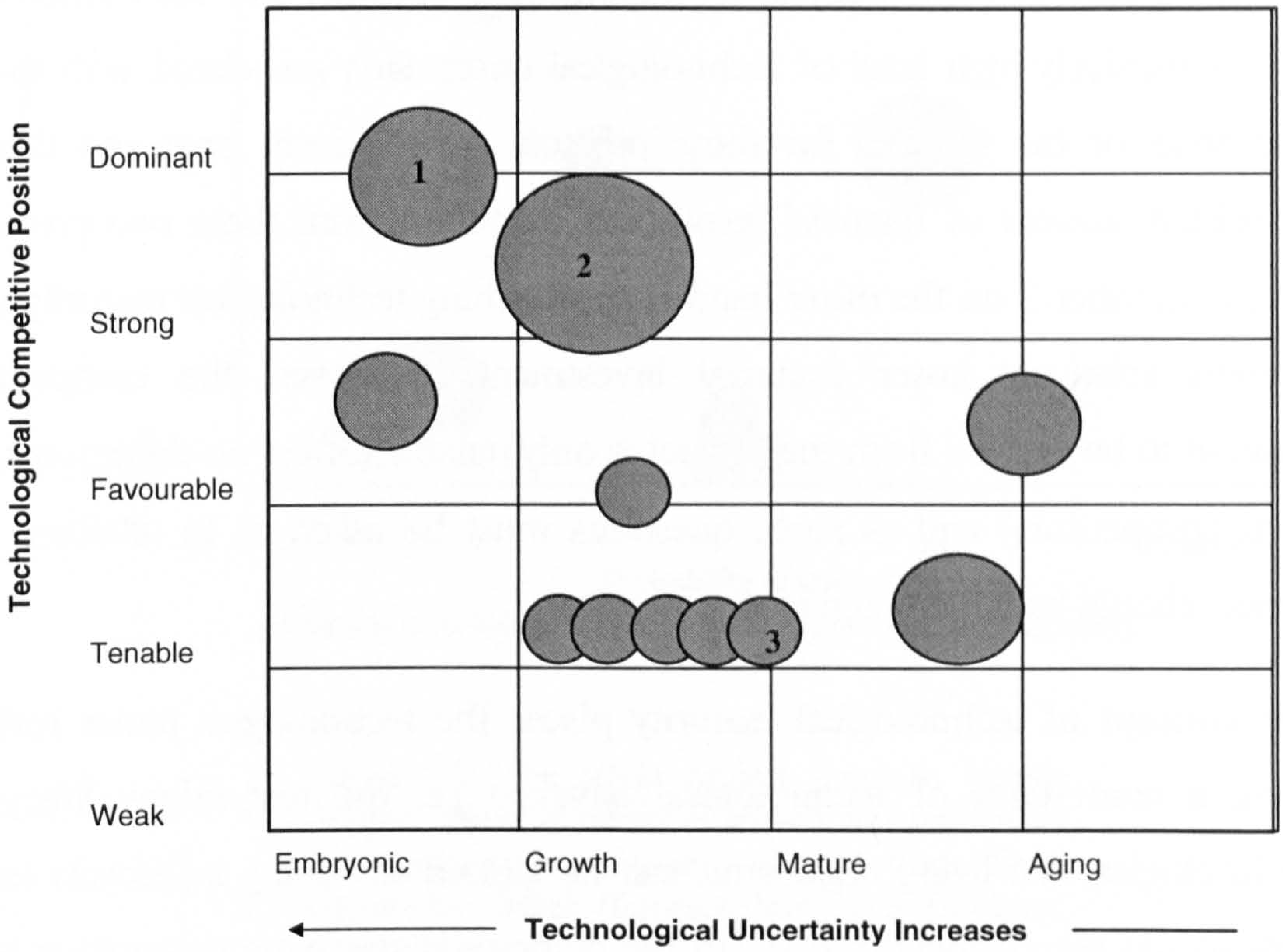
The specific sub-elements of project attractiveness and the importance of each element are situation-dependent. Judgments can be made against each element or values can be assigned to the elements to facilitate an assessment of the attractiveness of the project. Elements of project attractiveness, for example, may include fit with strategy, inventive merit, risk, reward, cost, time, etc.

For each project, an analysis of the above four key elements can then be used to develop portfolio models in diagrammatic form. These quite often take the form of "bubble diagrams", outlining the relationship and values of two or more variables for a number of projects under review. Examples of some standard diagrams used in portfolio analysis are given in the following section.

5.6 Portfolio Management Methods - Bubble Diagrams

For new product portfolios, the most popular "balance tool" is the use of various visual charts. Charts are favoured for their ability to visually display the balance of projects in the portfolio.

The diagrams are quite often used at the review stages of project meetings. Typically several different types of bubble diagram are involved, as outlined below:



The R&D Project Portfolio Bubble Diagram showing Competitive Position against Technological Maturity.

Figure 5.1: Adapted from Third Generation R&D
(Roussel, Saad, and Erickson, p102, 1991)

Figure 5.1 above illustrates how projects can be mapped using bubble diagrams. In this example, each bubble represents an individual R&D project and the area of the bubble is directly related to the project cost i.e., the larger the area of the bubble, the greater the project cost. For each project, the maturity of the technology is mapped against the technological competitive position of the project under review.

In the above example, Project numbers 1 & 2 would represent a strong to dominant position in terms of competitive strength, but the technologies are at an early phase in their lifecycle (embryonic and growth) and thus inherently have a relatively high level of technological uncertainty associated with them. The areas of the bubbles for these projects are relatively large and thus a significant amount of financial resource is associated with these two projects. Project number 3 on the other hand is approaching technological maturity and requires relatively lower financial investment. However, the competitive position to be derived from the project is only tenable (offers no differentiation from competitors) and as such, questions must be asked as to whether the project should be undertaken at all.

The concept of technological maturity places the technologies under review along a continuum of technological advance i.e. the technology lifecycle. Technologies, like living organisms, can be viewed as having a lifecycle from birth to old age (Appendix E (i). In the embryonic stage, the technology is at the birth stage. Little is known about the practical application of the technology and there is only a modest level of understanding of the underlying science. In the growth stage, much R&D advance still remains, but the technological uncertainty has been reduced. In the mature stage, the basic technology is now well understood by R&D personnel and the pace of advances in understanding slows, as does the scope for such advances. The ageing phase is characterised by incremental advances that are predictable and which can be easily copied by competitors.

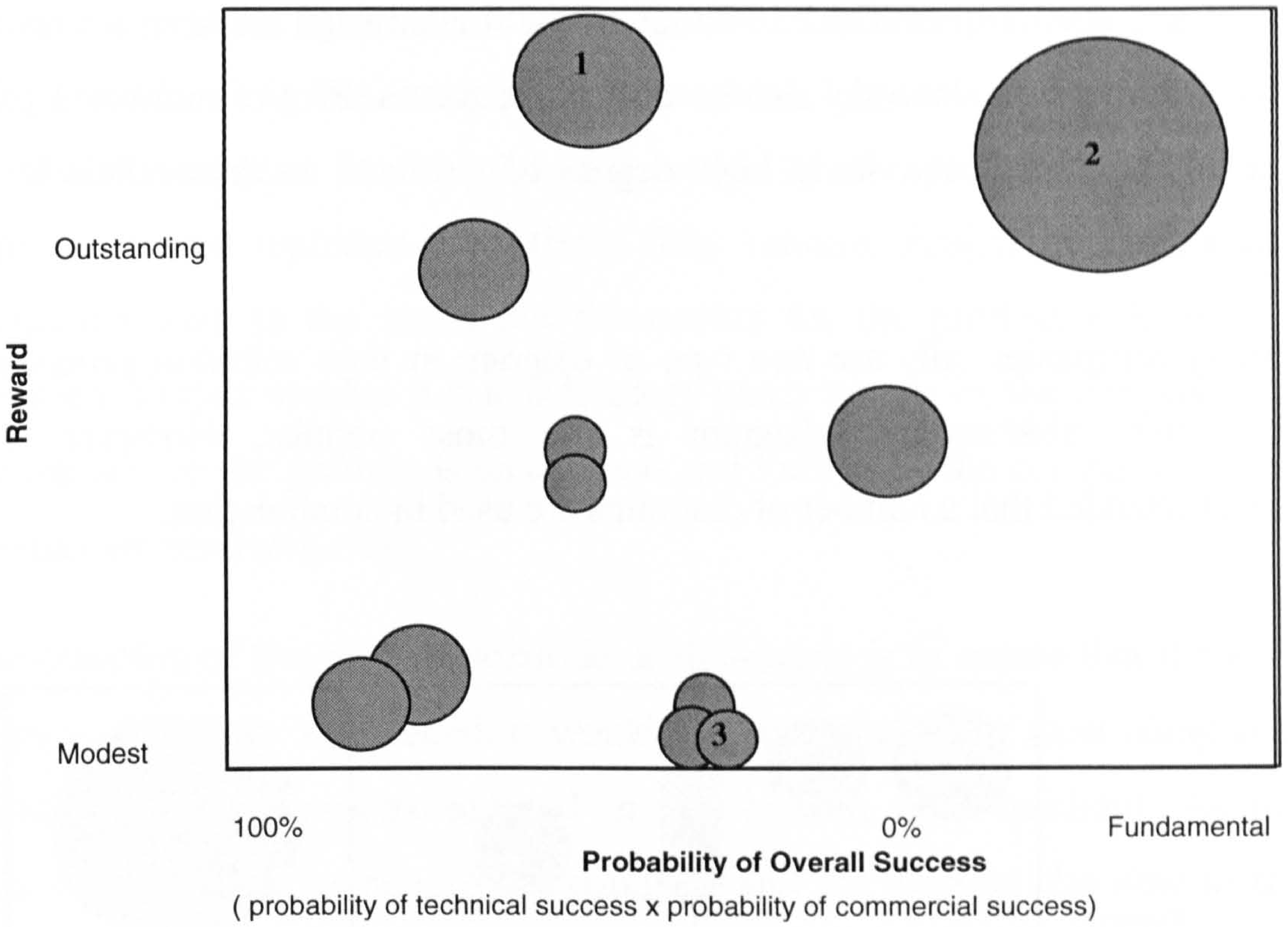


Figure 5.2: The R&D project portfolio bubble diagram showing potential reward and probability of overall project success, adapted from Third Generation R&D (Roussel, Saad, and Erickson, p104, 1991).

Next, the anticipated reward for each project can be compared to the probability of overall success, as in Figure 5.2 above. Both technical and commercial risks are considered. As most portfolio models attempt to maximise the value of the project portfolio, it is critical that a balance between risk and reward is attained.

In this example, project number 1 offers outstanding reward for a medium amount of risk. Project number 2 also shows an outstanding reward potential, but its risks are extremely high - so much so that the risks cannot be rated on the probability scale. As the project is a fundamental research project, risk is high and also unquantifiable. The nature of fundamental research means that the commercial value may also be difficult to assess. Project number 3 offers modest reward for a fairly high degree of risk and is thus relatively less attractive.

Many companies only use one type of diagram in their selection procedures, and this "risk/ reward" diagram is the most popular. However, it is recommended that a number of diagrams are used in combination.

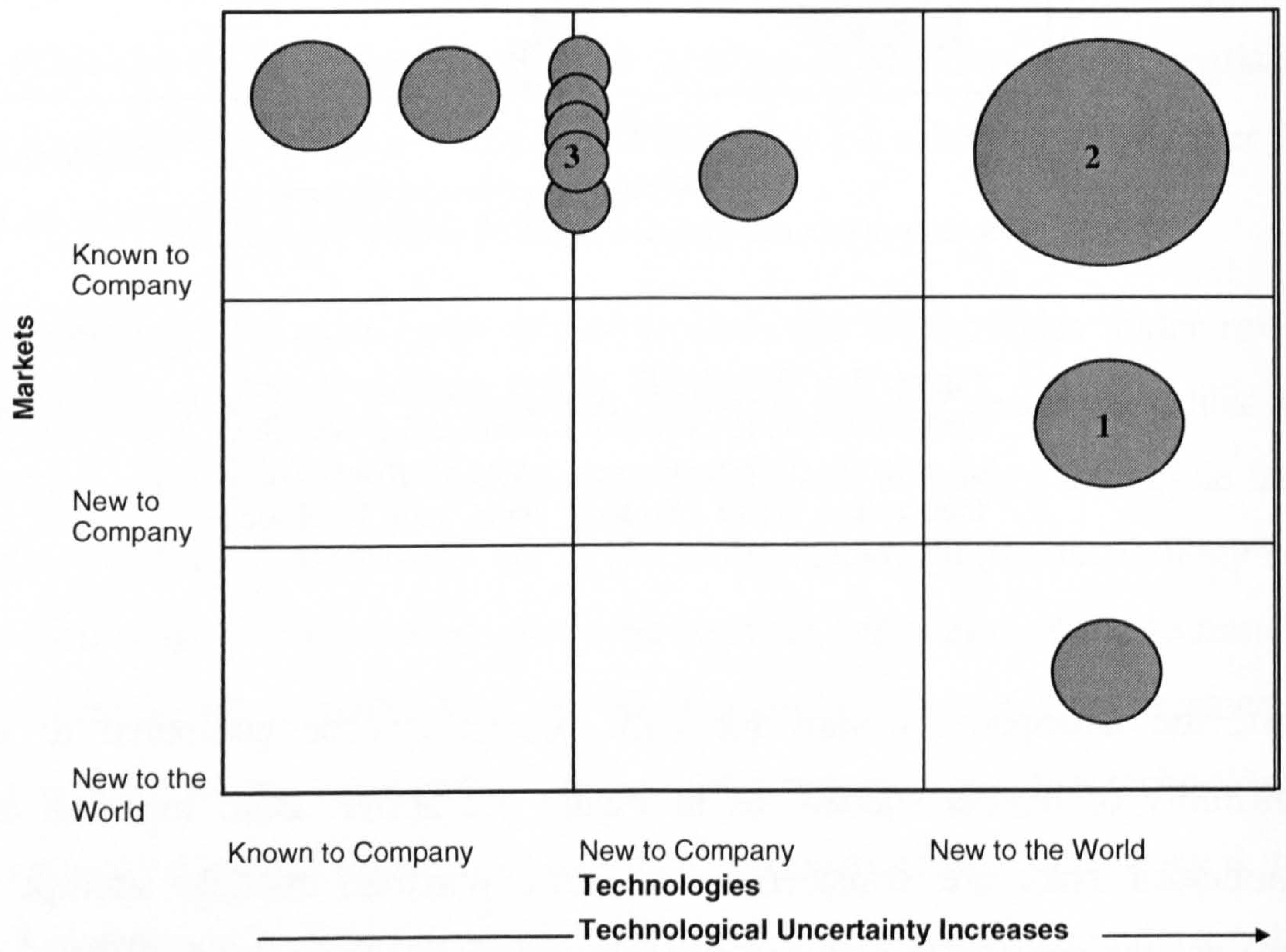


Figure 5.3: The R&D Project Portfolio Bubble Diagram showing Familiarity of the Technologies and Markets, adapted from Third Generation R&D (Roussel, Saad, and Erickson, p109, 1991).

Figure 5.3 shows a third bubble diagram that maps the company's knowledge of the technologies against its knowledge of the markets for the technologies being considered. In this example, project number 1 is a technology new to the world and the market for the product is new to the company, and thus for the company would represent a relatively risky venture. Project number 2 is a technology new to the world but the market for the product is known to company. Project number 3 is a technology partly known by the company and the market for the product is understood and known by the company, and so the risks are relatively small.

The objective of this type of portfolio analysis again is to ensure that the right balance of projects is obtained. It would not be desirable for most companies to have all their projects mapped in the bottom right quadrant. As the technologies would be new to the company and the markets also new to the company. This would represent an unacceptable level of risk.

5.7 Three Goals in Portfolio Management

The value of bubble diagrams lies in the effort by a management team to agree on the placing of each project on a diagram, and then on the use of the diagrams as visual aids to consideration of the whole collection of potential projects. Bubble diagrams are more an information display than a decision model per se. For example, if risk versus reward is being plotted for projects under discussion, it is visually apparent from the chart if too many risky projects are being proposed, as they will form a cluster at the high-risk end of the axis. However, the model will not in itself determine which projects to remove from the portfolio to get a better balance: it will only highlight the imbalance, and management must then decide which projects to remove or include.

The portfolio methods employed by companies can vary greatly, but the common theme is that the company is attempting to maximise some objective for all projects. Three broad goals may be sought after by companies for the projects under review:

(1) Maximisation of Value

(2) Balance

(3) Strategic Direction

5.7.1. Maximisation of Value

One of the main goals of companies using portfolio methods is to maximise the value of the portfolio of projects against one or more business objectives such as profitability, return on investment, risk, etc. Portfolio methods used in maximising values include bubble diagrams, scoring models and standard financial models. The result of this type of analysis is a rank-ordered list of projects, with the projects scoring the highest in terms of achieving the desired objectives at the top of the list.

5.7.2 Balance

A second goal of portfolio methods is the principal concern of achieving the desired balance of projects in terms of a number of parameters. For example, the right balance in terms of:

- long term projects versus short, fast projects
- high risk versus low risk, and reward
- familiarity of technologies and markets

- technological competitive position
- technology types (pacing, key, base)

The most common tool used in practice for analysing and establishing balance is bubble diagrams.[1]

5.7.3 Strategic Direction

Here the goal is to ensure that the final portfolio of selected projects is strategically aligned and truly reflects the business's strategic needs. For example, if a business's strategic objective is to "grow via leading edge product development", then this must be reflected in the number of new product projects and technologies included in the portfolio.

A second element in relation to strategic fit is to match resource allocations, both financial and human, to the portfolio of R&D projects. Here too, the balance must be right and match the stated business strategic objectives. For example, again if the desire is to develop new, innovative technologies through which to grow the business, then the R&D spending ought to be on projects designed to reflect this objective.

In some strategic fit models, factors are established and each project is reviewed against these factors using a simple Likert (1-10) type scale (Likert, 1932). For example, at Hoechst US Corporate Research & Technology, business strategy fit is assessed by rating a number of factors including congruence, impact, proprietary position, platform for growth, and synergy with other operations (Cooper *et al*, 1998).

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[1] The difference between the type of bubble diagrams illustrated on the previous pages and the McKinsey or Boston Consulting Group bubble maps of the 1970's is that, for new product projects the diagrams deal with future businesses or *what might be*, and not what is.

5.8 Discussion – Selection of a method to use in this research

Although the use of portfolio management in the field of new product development is now relatively widespread, there is no body of research that demonstrates its use or even its applicability to the area of manufacturing technology acquisition (MTA). Here, the primary mechanisms used in practice for project selection remain dominated by financial appraisal techniques such as payback, net present value, rate of return or some of the other deterministic methods discussed earlier. Lowe (1995) states that the three main techniques used to support technology investment decisions are the Payback method, Return on Investment analysis, and the Discounted Cash Flow method. Furthermore, he states that the simplicity of the payback method makes it attractive to many companies. The interviews in Chapter 4 of this thesis supported this viewpoint.

The challenges facing companies in selecting the appropriate and optimal technologies for manufacturing are similar to those for product development. For example, risks in acquiring automated manufacturing technology are often quite high and must be balanced against the potential for reward. Existing literature suggests that 50% to 75% of the U.S. manufacturing technology implementation efforts result in failure (Ettlie, 1986; Jaikumar, 1986; Majchrzak, 1988; Uzumeri and Walsh, 1990; Saraph and Sebastian, 1992; Chung, 1996). Any additional mechanisms that may improve the selection process would likely be of benefit to the wider industrial community.

The issues for a company undertaking MTA are similar to those for new product development project selection in that the company is trying to maximise the value of the portfolio, ensure strategic fit and have a balanced portfolio of MTA projects.

In deciding which techniques to adopt and test out in the field of MTA, the more complex methods proposed for use in NPD, for example, mathematical programming and AHP were discounted for a number of reasons:

(1.) there is little or no evidence in the literature to support their use or acceptance as a tool in companies for NPD or R&D selection in practice (Steele, 1988). Cooper *et al's* (1998) view is that few authors have ever described attempts to implement their methods and to gauge their feasibility. In contrast, Cooper *et al's* (1988) portfolio management techniques have gained widespread acceptance and are used in over 800 companies.

(2.) the researcher wanted to develop a relatively simple method for project selection that was wider in scope than DCF methods, yet not as complex as the mathematical programming models, and which would be accepted by the user community (manufacturing personnel) as a practical and easy to use tool.

Thus, having assessed the full range of methods and techniques available, Portfolio methods based on the work of Cooper *et al* (1998) and Roussel *et al* (1991) were chosen as being the most appropriate, given the objectives the researcher wanted to achieve.

The proposing of portfolio methods appropriate to MTA and the testing out of these methods in a live manufacturing environment over a three year period forms the basis of the next chapter.

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Chapter 6

A Case Study on the Application of Portfolio Management Techniques for the Acquisition of Manufacturing Technology.

6.0 Introduction

In this chapter, it is explained how project selection techniques derived from those used in the fields of NPD and R&D were applied to the selection of MTA projects within the researcher's Company. The lessons from doing this were noted and the methods were developed towards maturity over three annual cycles of project selection.

New constructs are proposed on how to use these techniques for MTA and the validity of these is tested in the Company's factories.

The research method used for this phase of the research was evaluation using the case method. As the research was taking place in a live, dynamic environment where the timeline was dictated by the technology needs of the business during each of the three years, the researcher had to seek approval from senior manufacturing management to test out the methods using real Company money.

6.1 Background on Manufacturing Technology Investment in the Company

As discussed in chapter one, in the late Eighties and early Nineties, the Company made significant investments in manufacturing technologies in Ireland. Historically, these expenditures were classified into five main categories:

(1) Manufacturing Expansion

(2) Manufacturing Technology Development/R&D

(3) Cost Reduction

(4) Manufacturing Replacement Capital (replace old machines)

(5) Compliance with Health & Safety Legislation

This classification was adopted from the U.S. Parent Company in accordance with how its accountants liked to classify expenditures. The manufacturing expansion, manufacturing replacement and health and safety categories often involved the acquisition of manufacturing equipment already in use by the Company, which was regarded as having already been proven in a production environment, unless they were being replaced by a newer generation of the same technologies. However, the categories of manufacturing technology development (R&D) and cost reduction projects usually involved acquiring technologies "new to the company" or even "new to the world".

As with most companies, there was a finite amount of finance available to support projects, and the challenge was to select the most appropriate projects to support the needs of the business.

6.2 History of Project Selection in the Company

Prior to 1996, the Company's approach to project selection was based on financial appraisal and a prioritisation of projects by rank ordering the projects primarily on payback period. Projects were considered individually and the highest priority ones were approved. This was the case for both manufacturing development type projects and cost reduction projects. No formal account was taken of the risks associated with the acquisition and there was an implicit assumption that all technologies received from outside the Company would be made to work.

However, as is suggested by the literature in the field, the Company encountered many failures in the technology acquired during the period 1990 to 1995. The failure rate was running in the region of 10 to 20%[1] which is not as high the 50% to 75% failure rate stated in the literature (Chung, 1996). The Company had at that time a conservative approach to investing in innovative technologies, tending to opt for equipment already proven in a production environment, or equipment where the risks were viewed as being limited. Also, it was believed that high quality project management procedures and effective team management practices contributed to the relatively low levels of failure. At this point it must be stated that not all project failures could be attributed to weaknesses in project selection methods alone. Opinion within the Company was that some project failures were due to problems in design, in-house skills base, supplier support, and so forth. Nevertheless, selecting inappropriate projects (poor strategic fit, excessive risk, imbalance) at the review stage was still regarded as a contributory factor for failure.

The failure rates were regarded as unacceptable by management and represented a significant monetary loss, hence the willingness to review the project selection procedures, and their decision to sponsor this research work. On reflecting on the methods used for selecting MTA projects prior to 1996, one General Manager in manufacturing in the Company commented:

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[1] On a typical annual capital spend of around $20 million in Europe in the early Nineties, $2 million or more could have been spent on technologies regarded as being unsuccessful. One example in the Company from this period was the acquisition of twelve automated sewing machines (model – Union Special HSLT) for the Automatics Sewing Unit. These machines failed to achieve the required production targets due to excessive mechanical failure.

> *"In how we decided which technologies to acquire, and how we tested and implemented manufacturing equipment, I would say categorically that we got things wrong".*

6.3 1996 Project Selection Methods

In late 1995, the Company agreed to test the application of a limited number of portfolio tools for assisting in the 1996 round of MTA project selection process. Once the list of candidate projects had been established and key data relating to each project compiled, the mapping process commenced. At this exploratory phase in revising the project selection process, only manufacturing technology development (R&D) projects were mapped. Cost reduction projects were omitted from the exercise, as the consensus of opinion by senior management was that most of the risk lay with development projects. The project list for 1996 is shown in Table 6.1.

MANUFACTURING RESEARCH & DEVELOPMENT PROJECTS - 1996

Project No.	Project Name	Project Cost	Annual Savings	Payback Years
11	Sulphur Dyeing	$71,748	$1,445,790	0.05
5	Auto Close Sleeve Loader machine	$31,500	$393,269	0.08
1	Laser Scanner	$75,000	$900,000	0.08
12	Jet Sew Auto Waistband machine	$15,000	$92,376	0.16
9	Dye Jet Unloading System	$50,000	$162,081	0.31
7	Continuous Bleaching	$350,000	$878,823	0.40
2	Jet Sew Auto Hem & Close Sleeve Feeder	$33,333	$30,000	1.11
8	Water Recycling project	$1,024,500	$800,000	1.28
4	Jet Sew Bottom Hem Loader	$100,000	$45,795	2.18
6	Automated Preparation machine	$37,500	$12,000	3.13
3	Pegasus SN Auto Hem & Close Sleeve	$75,000	$21,000	3.57
10	Biomass	$10,000	$1,000	10.00
	Total	$1,791,833	$3,336,344	0.54

Table 6.1: 1996 Project List, with projects ranked in order of payback calculated at this time.

This table shows only the standard project data that would have been used prior to 1996. Traditionally, for those projects getting past the initial filtering process, financial support would have been sought by the Vice President of Manufacturing to undertake the selected projects. The traditional filtering process was based on a consensus method i.e. the R&D Manager and the VP of Manufacturing would decide which projects should proceed, based on an assessment of each project using the payback data, and a very arbitrary appraisal of other factors, such as manufacturing strategy.

On this occasion, with the start of the testing of portfolio methods, the next process was to map other project parameters used in portfolio methods such as risk versus reward. After an examination of the models used in Third Generation R&D (1991), it was decided that modifications were required to make them applicable or relevant in the context of manufacturing technologies. For example, in the risk versus reward bubble diagram (Figure 6.1, compared to figure 5.2), the X axis was changed to "risk" and split into four categories of types of R&D activities or technologies to be acquired (Fundamental, Radical, Incremental and Proven). Although Third Generation R&D (1991) covers the categories of fundamental, radical and incremental R&D (Appendix F (i)), it does not allow for the use of so called "proven" technologies which is relevant in the context of manufacturing technologies. Alongside these categories, an assessment of the probability of technical success (risk) is given on a scale from 0% to 100%, and from high to low. The Y-axis was kept the same - reward, ranging from modest to outstanding. Reward at this stage was still viewed as a measure of financial return from the project. This is illustrated in Figure 6.1 where risk versus reward is mapped[2] for the projects under review.

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[2] The bubble diagram of risk versus reward was mapped using Microsoft Excel. The researcher had attempted to use Harvard Chart XL for generating the bubble diagram direct from the spreadsheet using this tool, but it proved to be too cumbersome in actual use. Thus, the charting is done using MS Excel.

This mapping added a new dimension to the project selection process. The risks were estimates based on preliminary investigations by the relevant technical personnel involved in the project within the Company i.e. those who would have to carry out the project were it to be approved. For each project under review, the financial return (annual savings from project) was estimated and the risks stated, alongside a description of the project and other relevant project details. This was presented in a "Manufacturing R&D Project Submission Form" to the R&D Manager who would then collate details on all projects and generate the actual bubble maps and a portfolio summary. Personnel involved in the project review process were then instructed how to interpret the portfolio diagram and the "Review Panel" reviewed the projects.

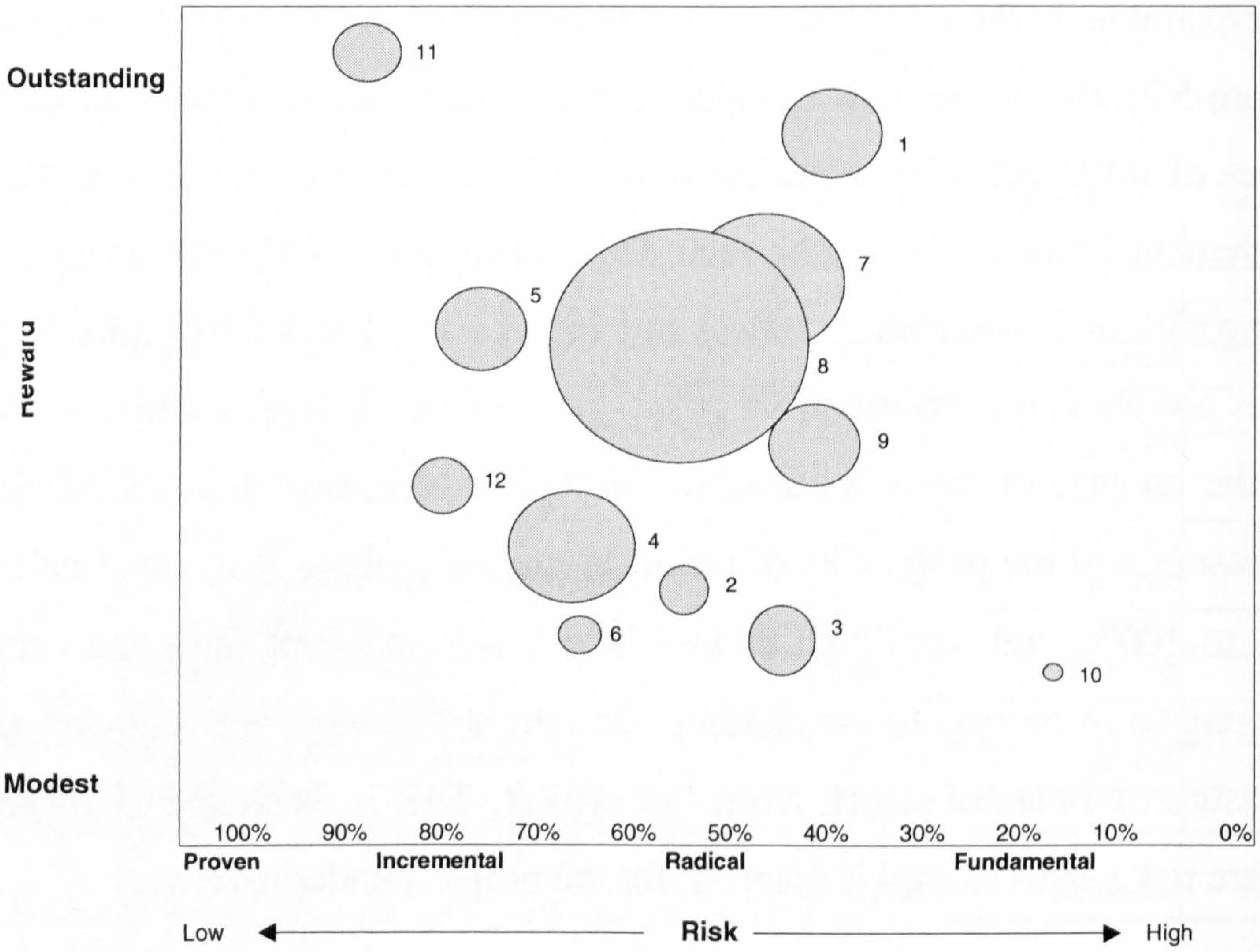

Figure 6.1: 1996 Project Portfolio - Risk versus Reward Bubble Diagram.

6.3.1 Outcome of the Selection Process - 1996

The outcome of the selection process is now discussed using some examples from the project list. A group of four people, collectively known as the “Review Panel”, reviewed the project list using the tabulated portfolio data (Table 6.1) plus, for the first time, the risk versus reward bubble diagram (Figure 6.1). The review panel members were:

- R&D Manager
- Vice President of Manufacturing
- General Manager of Manufacturing – Textiles
- General Manager of Manufacturing - Apparel

A few examples of the projects being reviewed in this selection round are now discussed.

Project number 1 offered significant annual savings and a relatively low project cost to develop, which meant that the payback was extremely favourable. However, the risks associated with the project were determined to be relatively high (40% to 50% chance of success) as the project involved the innovative use of laser technology to detect fabric defects while the fabric was being knit. Nevertheless, it was agreed to proceed with the project due the high financial returns. Also, the system would have to be put onto each knitting machine, and thus had the potential to be applied widely. At the time, there were about 240 knitting machines in the Company in Europe, with well over 1,000 machines in Fruit of the Loom’s U.S. textile plants.

The approved project was developed jointly by the R&D Manager and an R&D Project Engineer, who had experience in optics, lasers and digital signal processing (the fundamental science and technologies on which the system was based). This project was undertaken as a collaborative project with two universities. A prototype detection system was eventually developed and is shown in figure 6.2.

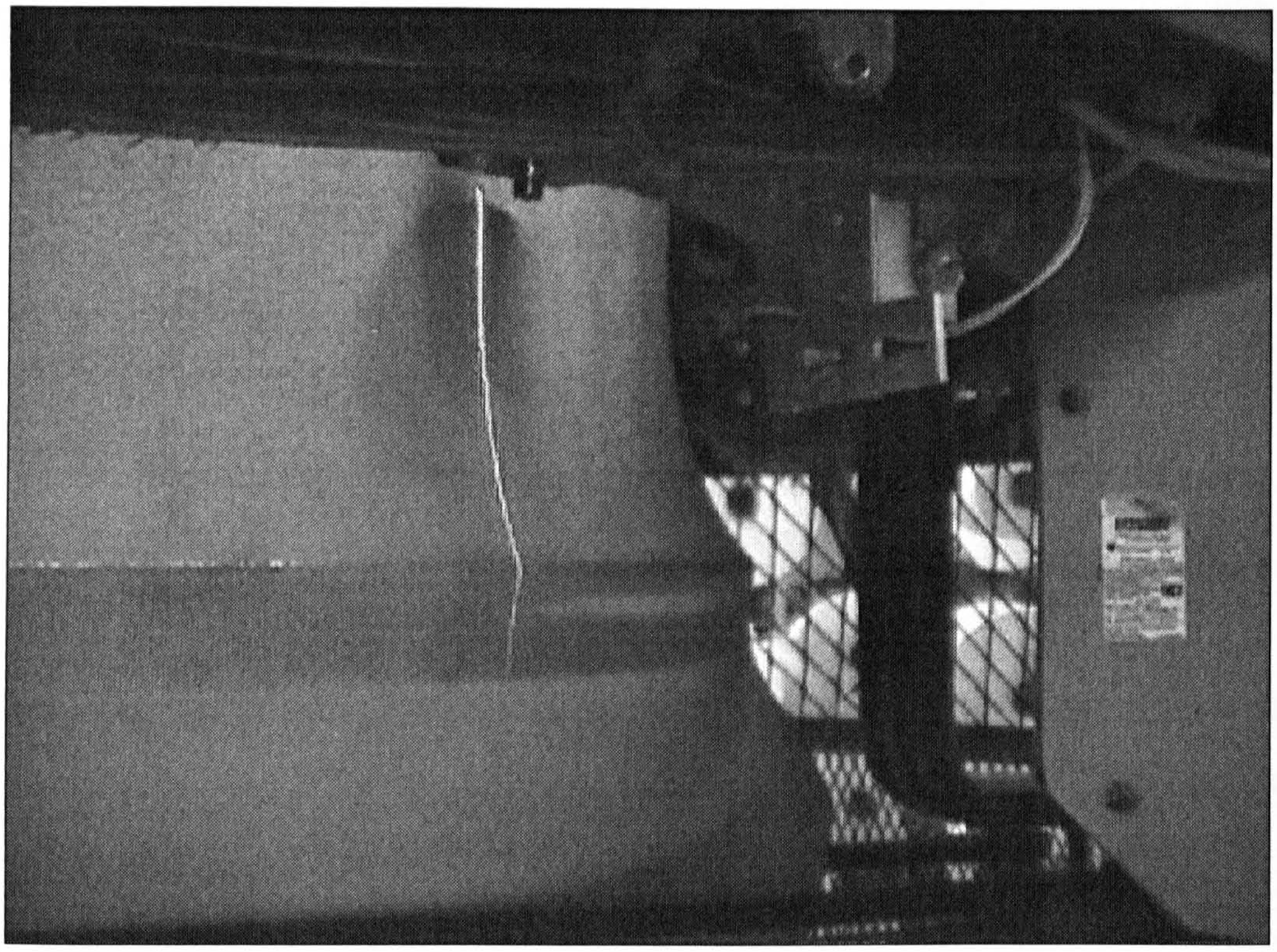

Figure 6.2: Project number 1 - a fabric defect detection system, using laser technology.

Project number 8 consumed a large amount of the overall project budget and had reasonable reward potential, and an acceptable payback period. However, the risks were regarded as being too high for this amount of financial outlay and consequently the project was rejected. If this project had been evaluated without the risk assessment, it would possibly have been accepted.

Project number 10 was a fundamental research project. Even though all the evaluation metrics indicated that it should have been dropped off the list, the project was actually undertaken, as the view was that the information obtained may be useful to the Company in the future. The project was a collaborative project with a number of external bodies, including two universities, into the potential of using “biomass” as a source of energy for small industries located in a rural setting. It was also a low cost project. Thus, there was an implicit strategic element in the evaluation of this project even though strategic fit was not a formal assessment criterion.

As another example project number 6, an automated preparation machine in the Dye Plant, was accepted despite having a payback of over three years. It was viewed as being relatively low risk, and could be applied widely. Also, it was necessary to develop a new preparation machine as the prior process (knitting) had changed its product output, generating a physically larger roll, that the existing machine was not designed to process. This machine was designed and developed by the Company’s R&D engineers, and is shown in figure 6.3.

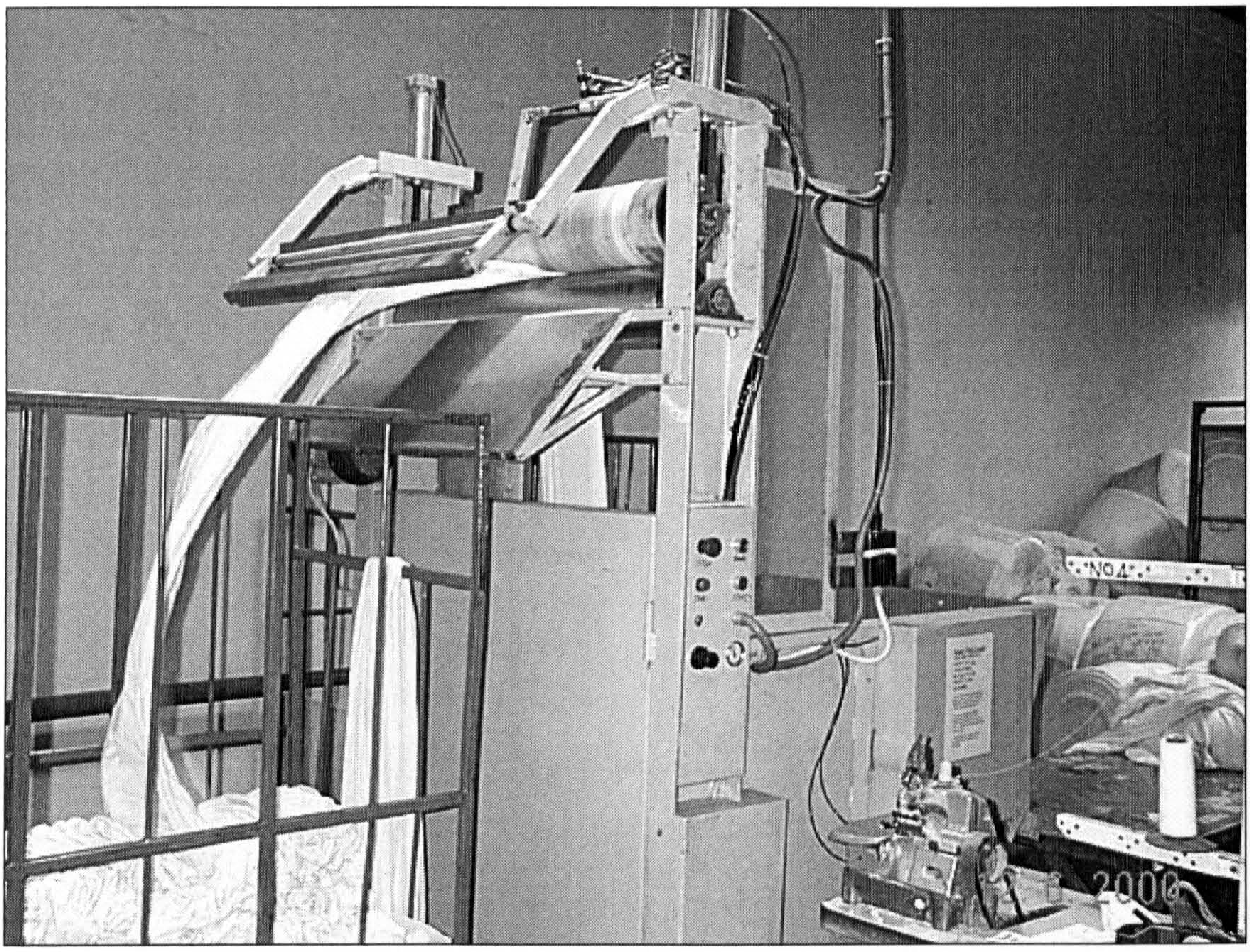

Figure 6.3: Project number 6 - an automated fabric roll unloading machine (known as a preparation machine) developed subsequent to the 1996 project selection review process.

All of the remaining projects on the list were accepted at the review stage. On analysing the balance of the overall portfolio in terms of risk versus reward, it was the view that the balance was quite good now that project number 8 had been dropped. However, what became apparent was that some manufacturing process areas were under-represented as only four out of a total of six distinct manufacturing process areas (e.g. dyeing, spinning, etc) were included in the analysis. This in itself was not a problem, but the fact that other areas were not even considered and that no projects had been proposed for these areas was seen by the panel as requiring further investigation.

6.3.2 Discussion of the 1996 Selection Process

Overall, the review panel decided that the use of a visual aid in the form of a bubble diagram was quite useful and should be developed further. However, to a large extent, the rank ordering of projects still was based primarily on the payback method whose inherent limitations were discussed in chapter five. Nonetheless, the bubble diagrams had addressed the issue of the balance of projects and an assessment of risk for each project, and the whole portfolio was discussed for the first time. At this stage, it was hoped that further use of the methods during subsequent annual selection cycles would address the known shortcomings.

All projects were selected and the total project spend was about $1.5 million.

6.4 1997 Project Selection Methods

The principle of portfolio management was again used to assist in the decision making process for the 1997 manufacturing technology project list (Table 6.2).

RESEARCH & DEVELOPMENT PROJECTS - 1997

Project No.	Project Name	Project Cost	Annual Savings	Payback Years
7	Filter Flow 2000	$15,000	$120,000	0.13
22	Combined 2N	$22,000	$64,000	0.34
20	Auto Bottom Hemmer	$55,000	$136,000	0.40
19	Auto Hemmer Seamer	$75,000	$180,000	0.42
17	Auto Band Leg	$30,000	$56,000	0.54
18	Auto Close Leg	$32,000	$59,000	0.54
10	Garment Dyeing	$100,000	$141,000	0.71
9	Fabric Unrolling machine	$30,000	$40,000	0.75
13	Pad Detwister	$60,000	$71,500	0.84
27	Auto Fold machine	$60,000	$70,000	0.86
8	Lint Catcher	$7,000	$8,000	0.88
26	HSLT Conversion	$71,000	$80,000	0.89
28	Auto Pallet machine	$80,000	$90,000	0.89
6	BDM Project	$90,000	$85,000	1.06
21	Auto Loader	$85,000	$72,000	1.18
5	High Frame machines	$150,000	$123,000	1.22
11	Low Temperature Dyeing	$50,000	$40,000	1.25
12	Wet Oxidation	$42,000	$30,000	1.40
14	Dye Jet Controls	$39,000	$26,000	1.50
4	Fabric Coding System	$48,750	$31,000	1.57
15	Data Collection System	$75,000	$46,000	1.63
1	Packing Line Control Mods	$20,000	$11,000	1.82
2	Automated Bale Opener	$150,000	$72,000	2.08
25	HP for QC	$50,000	$20,000	2.50
23	211E	$37,500	$13,000	2.88
3	Fabric Inspection machine	$30,000	$10,000	3.00
24	266T	$39,000	$12,500	3.12
16	BRB Plates	$31,000	$9,000	3.44
	Total	$1,574,250	$1,716,000	0.92

Table 6.2: 1997 Project List - ranked in order of payback.

The manufacturing technology acquisition project portfolio for 1997 contained a greater number of projects than the 1996 portfolio. This was in part due to a direct effort to ensure project coverage across all manufacturing process areas. The bubble diagram of risk versus reward is shown in figure 6.4.

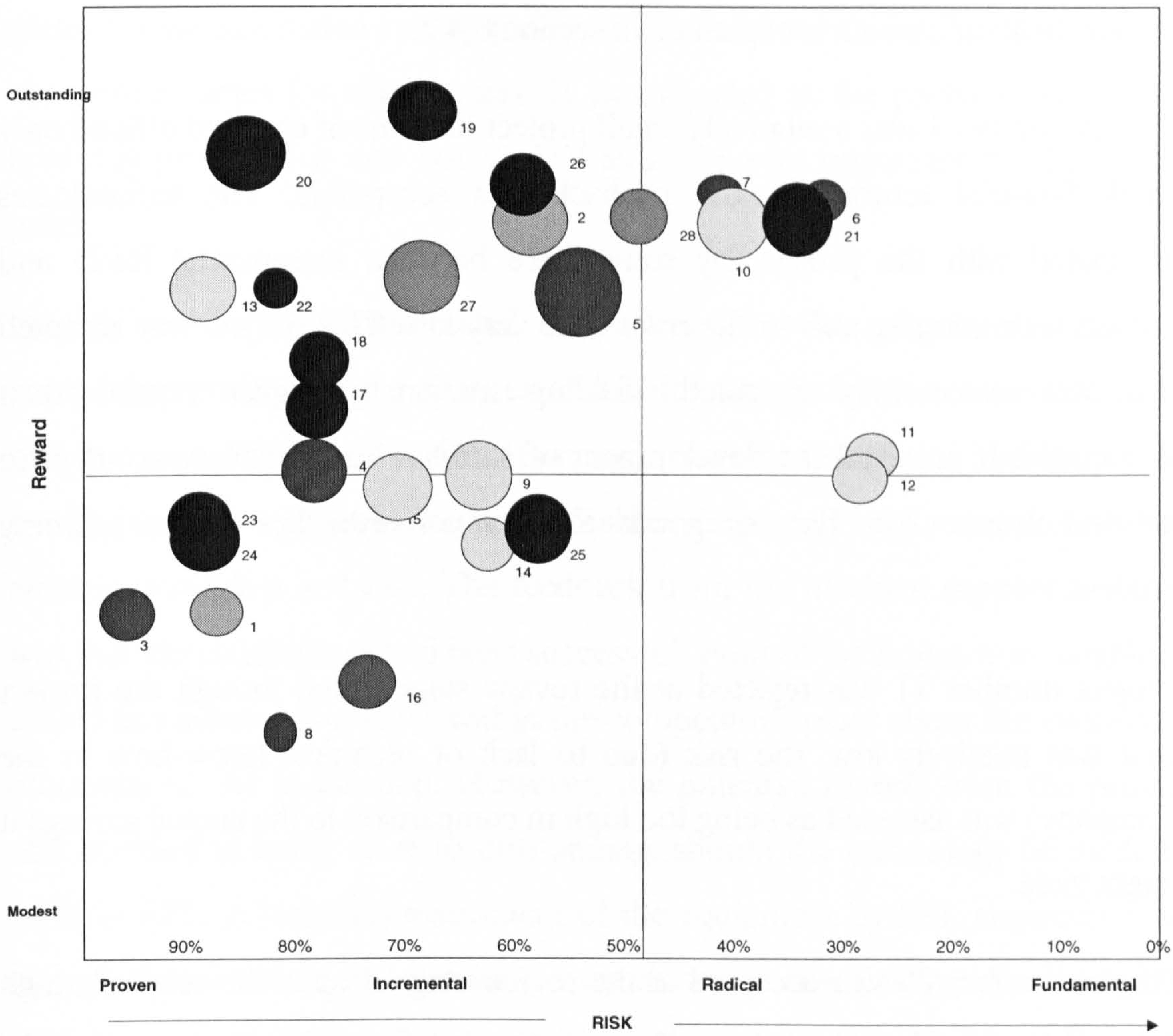

Figure 6.4: Risk versus Reward Bubble Diagram
1997 - Project Proposals Portfolio

As the budget for projects in a given year was usually fixed, covering more manufacturing process areas resulted in a greater competition for funding among projects.

6.4.1 Outcome of the Selection Process - 1997

The manufacturing technology acquisition project portfolio was evaluated by the same Company review panel as in 1996. Again, some of the projects are discussed below to demonstrate the use of portfolio techniques using actual

Company examples. In carrying out this selection, a new concept emerged, that of “Replication”, which is explained in section 6.4.2.

Project number 1 was a relatively small project in terms of cost and offered only small financial return, yet the payback was acceptable. The technologies associated with the project lay somewhere between incremental R&D and proven technologies, and so the risks were very low. This project was accepted and was successfully executed, yielding marginally higher returns than anticipated. It involved the development of software and hardware controls to aid and monitor the flow of goods along a conveyor line in the spinning process.

Project number 11 was rejected at the review stage. Even though the project cost was relatively low, the risk (due to lack of technical know-how in the Company) was assessed as being too high in comparison to the annual savings it might yield.

Project number 25 was accepted at the review stage despite the relatively high risk and the lengthy two and a half year payback. The project was unsuccessful and maybe in hindsight should not have proceeded. An external factor probably contributed to an error in judgment by the panel, this being pressure from U.S. corporate senior management to adopt the technology despite the risks, because the U.S. operations were in the process of adopting this technology. The project involved the adaptation of HP palmtop computers for collecting quality data in sewing by inspectors patrolling the sewing plant, entering data remotely before downloading to a central system. FTL Europe was relying on the U.S. developing the central software for data storage and reporting, and the U.S. personnel failed to deliver on this. Thus, the project failed.

Project number 16, BRB Plates, concerned the development of special cutting plates for the automated cutting process that would result in reduced set-up and changeover times for this process. It was rejected as the payback period was relatively poor and it was not viewed as being very important by the review panel.

Project number 2, an automated bale opener for the spinning process was accepted, even though the chances of it being successful were estimated to be only between 50% to 60%. Only two such machines had been installed in the world, one at a competitor's plant in Rabun, Georgia, U.S.A., and the other at an unknown plant in Israel. The feedback from the machine supplier in Israel was that the installations had been successful. Fruit of the Loom were unable to obtain any information from within the competitor's plant about the success or otherwise of the installation. However, the potential reward from the project was assessed as being close to outstanding, should the technology be made to work in FTL. A technical assessment of the equipment by FTL engineers took place in Israel before the decision to purchase the machine was finalised. The machine was acquired and successfully implemented, although it took over six months from receipt to getting the desired output from the machine post installation. The bale opener machine is shown in figure 6.5.

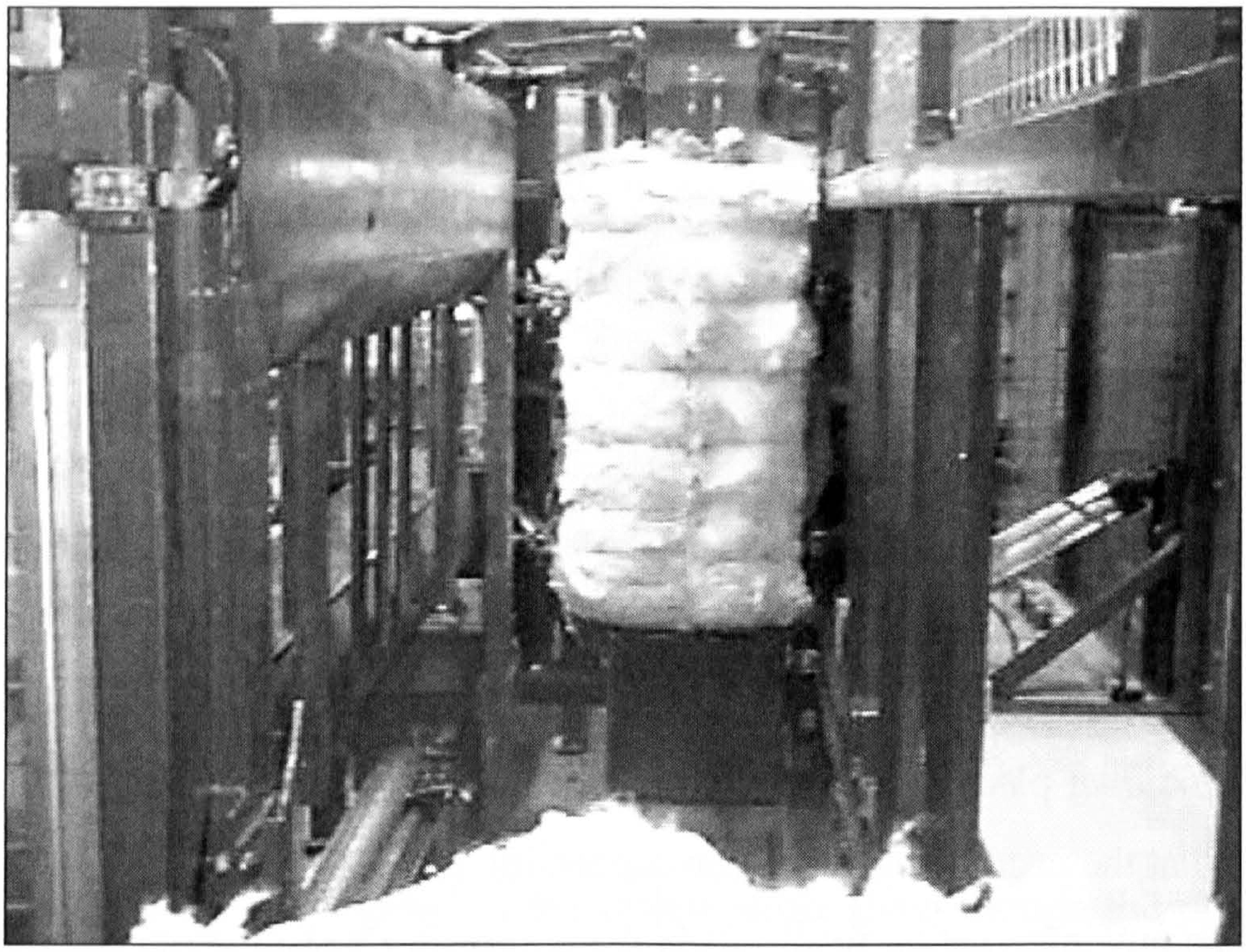

Figure 6.5: Automated Bale Opening machine for removing hesian cover and wire from cotton bale.

Project number 10, a proposed new method of garment dyeing, was rejected despite having a very attractive payback. The primary reason for rejecting it was because of where the project had ended up on the risk/ reward bubble diagram. The VP of Manufacturing, who had a chemical engineering background, regarded the process chemistry as "too novel and unproven". It was viewed as being just too risky a project. Also, there were concerns over resource availability as the Company only employed three chemists at that time.

6.4.2 The Replication Concept

Project number 19 was approved due to the potential financial savings from the project, the risk being regarded as acceptable for this degree of return on investment. This particular technology had only been on the market for two months and the acquisition represented only the second installation of the machine anywhere in the world, with the outcome of the first installation in a competitor's company not yet being available. The machine itself was an automated sewing system for assembling Tee shirt sleeves.

After an initial period of debugging and some minor modifications to the design, the machine attained the desired output levels and the Company subsequently purchased a further eleven of these machines. Thus, having proved that the machines were successful by taking a risk on the first one on a single machine trial basis, the Company could then attain the same attractive payback a further eleven times, and now without risk.

Hence in MTA projects, a new important factor must be examined as part of the decision making process, that of the potential to apply the new technology being tested in multiple units, possibly across many manufacturing locations. In theory the more units that can be applied, the greater the returns to the Company. This I have called the "Replication Benefit" of the project.

Project number 5 was also undertaken even though the risks were determined to be relatively high. The annual savings estimated at the preliminary stage were in the event more than realised and the replication of this technology throughout the Company is now over eighty percent complete. Eventually the full deployment of these machines will yield returns running into millions of dollars per year. This project was carried out in the knitting process area and involved the conversion of process equipment from "low-frame" to "high-frame" machines, which operate at a significantly higher speed (r.p.m.). Another benefit of this project was that it resulted in significantly less waste fabric being generated, and to less stop time for the machine over the process cycle time. The fact that over two hundred of these machines were in operation across two sites meant that the potential for "Replication" was very high, and after the initial trial and evaluation of one machine, approval was given to proceed with the project across all locations.

Previous to the development of the replication concept, the practice was to purchase large numbers of a promising machine, rather than just one for a first evaluation.

Project 14 was accepted even though its replication potential was limited. This is because it was more a central control system development, which spanned a range of machines in a single implementation. It monitored the performance status of dyeing machines on-line. An example of the machine status viewing screen developed by the R&D engineers is shown in figure 6.6 below.

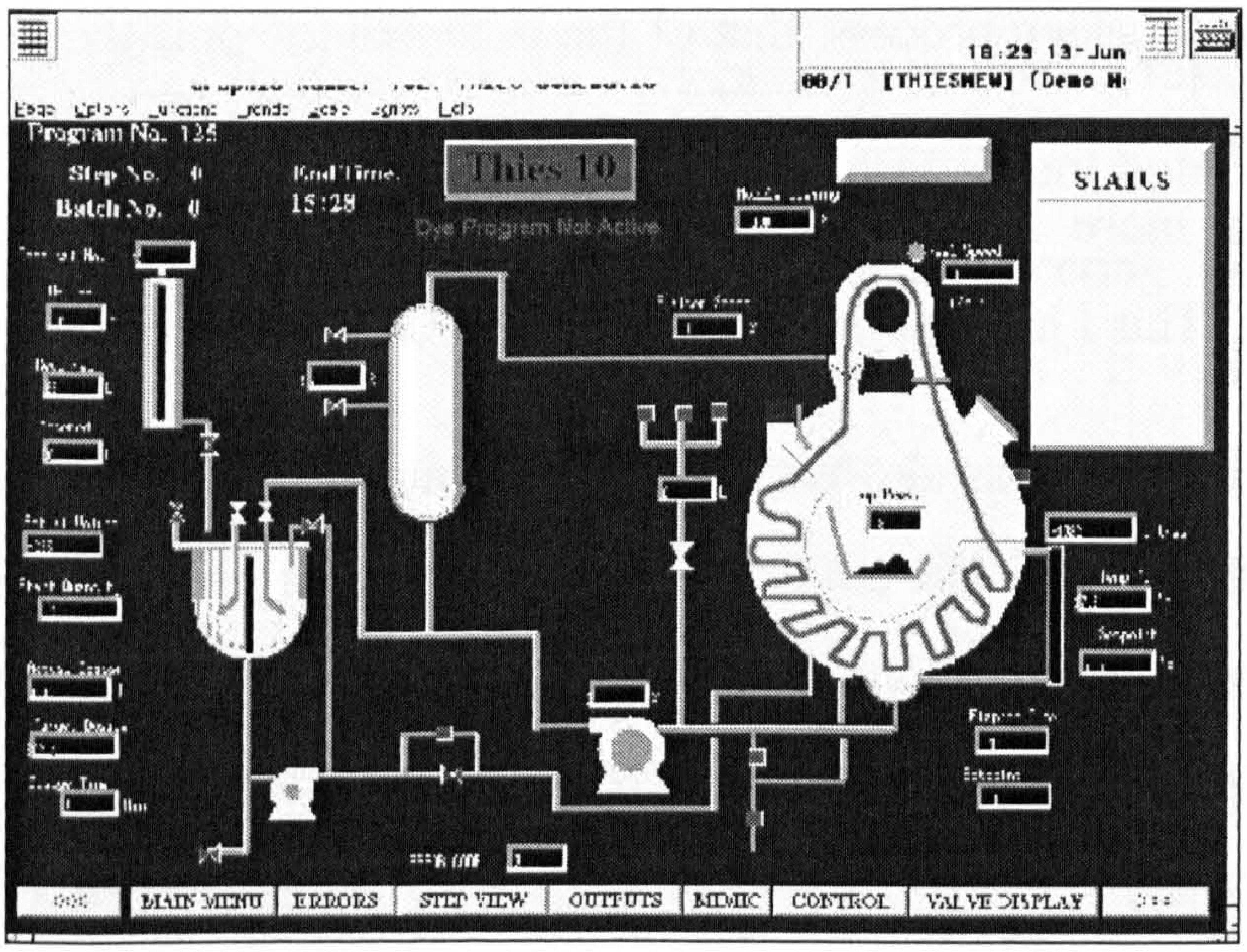

Figure 6.6: Supervisory Control and Data Acquisition (SCADA) screen developed for monitoring dyeing machines.

Project number 8 was accepted too because the payback was excellent at less than one year. More importantly, the device was designed and built by an internal R& D Project Engineer, and offered the potential, if successful, to be replicated across over 200 knitting machines yielding significant cost savings. This simple device, named a "lint catcher" was designed to catch airborne lint generated during the knitting process, and other contaminants. This prevented the contaminants from falling down inside the tube of fabric being knit, resulting in defective fabric being manufactured. It was developed, tested and ultimately replicated over 200 machines in the two knitting facilities. The device is illustrated in figure 6.7 below.

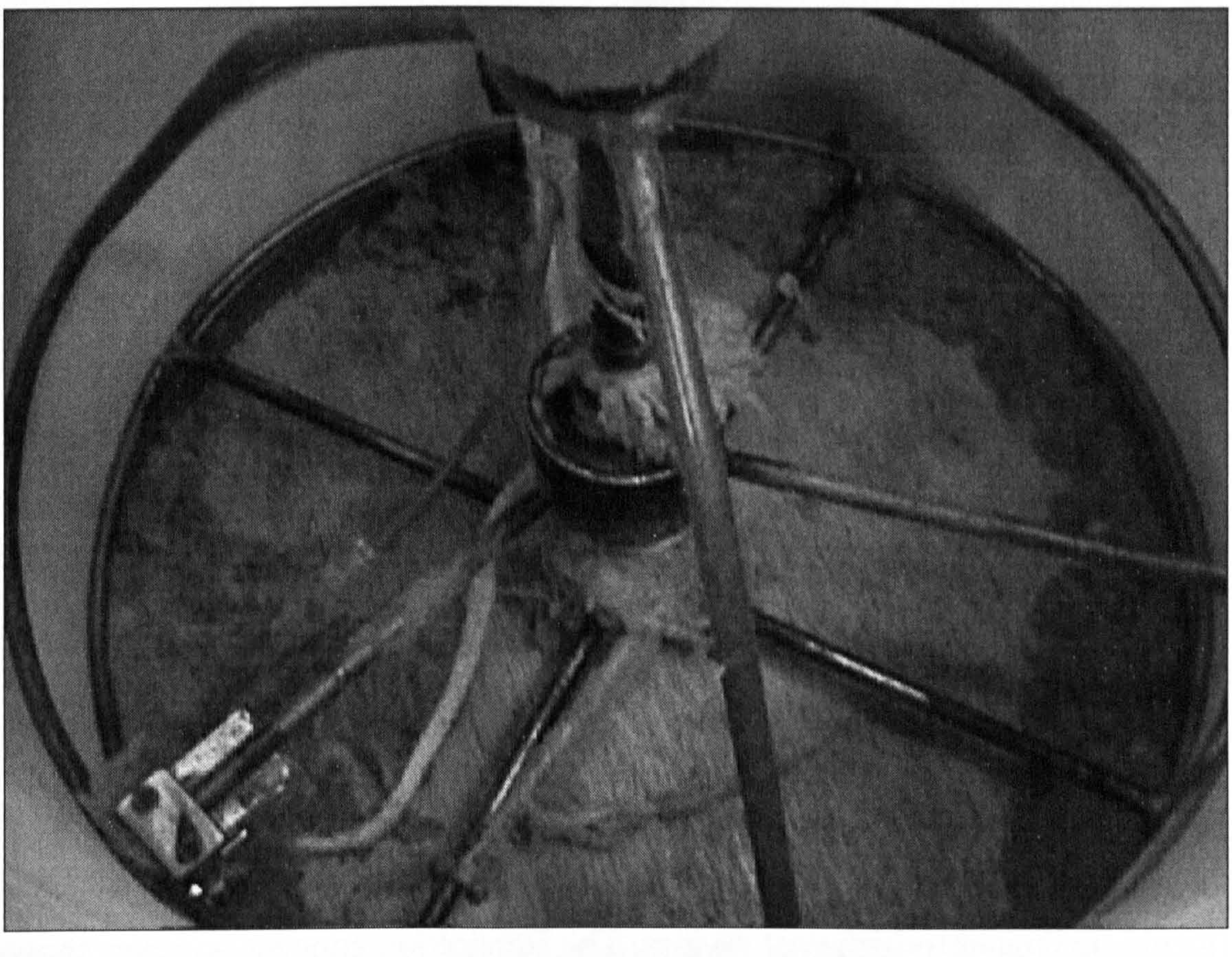

Figure 6.7: A Lint Catcher device, showing the build up of contaminants that would have otherwise fallen into the fabric tube causing defect cloth.

6.4.3 Discussion of the 1997 Selection Process

The 1997 portfolio was regarded as being an improvement on that of 1996. The portfolio had a reasonable balance in terms of risk and reward and all manufacturing process areas were represented. However, on closer examination of the projects against the three macro goals for portfolio management - value, balance and strategic fit - some fundamental questions arose from within the panel. How were the business strategy needs being considered? Was sufficient focus placed on the areas of manufacturing where maximum benefits could be attained? Why were some of the selected projects still resulting in failure?

In conclusion, the objectives of maximising the value of the portfolio and achieving balance were to a large extent satisfied, but it was considered by the panel that strategic importance and fit with business strategy criteria were not explicitly considered in the portfolio review process.

Another additional, novel feature adapted in the bubble diagram in 1997 was that each of the process area bubbles was given a different colour, to represent that manufacturing department. Spinning was light blue, sewing dark blue, etc. Therefore, at a glance, it was possible to see if a manufacturing process area was over or under-represented in the portfolio. This was new in the use of bubble diagrams and was agreed by the panel to be a simple, yet effective improvement where a balance of projects across functional boundaries is being sought.

A difference between NPD and MTA is that in NPD, a new product might achieve blockbuster sales whereas it might be thought that an MTA project would be limited to high cost savings. The Replication concept however shows that an MTA project can lead to rewards in proportion to the number of opportunities there are for its replication if it is successful during the trial phase. This can dramatically change decisions in favour of some high-risk projects.

After selection the total spend on projects ended up being about $1.2 million against the original submission of $1.574 million.

6.5 1998 Project Selection Methods

In mid 1997 when the process for establishing the 1998 project list got underway, a decision was taken by the Company to further improve the selection process. Additional research was undertaken into the latest portfolio methods used for new product portfolio management, as the tools used up to this point were accepted by the Company as being an improvement on standard financial appraisal methods. Upon completion of this additional research, a number of extra portfolio tools were tested and later incorporated into the Company's portfolio management process. These included techniques appearing for the first time in the literature in 1997 and 1998, for example, Expected Commercial Value (ECV) as used in NPD project selection.

Another major change occurred in developing the technology acquisition project list for 1998. During the ideation and concept generation phase, the Company not only used traditional technology scanning and forecasting techniques, it also consulted widely within the organisation to elicit new project ideas. This trawl was extensive and generated 122 project concepts. The practice prior to this had been that R&D personnel generated the majority of project ideas, with some limited consultation with manufacturing personnel.

The first phase of the evaluation process involved an initial assessment of the 122 projects by the review panel. This was necessary as there were more projects on the list than the Company could undertake, being constrained financially and by human resource availability (the total request for the 122 projects was $10.11 million - more than was available in the budget). The criteria used for the initial evaluation were purely financial (cost, savings and payback).

However, most of the projects removed from the list were ones which did not fall within the terms of reference for manufacturing technology acquisition projects, and they were reclassified into other groupings of expenditure. These included quality improvement, product enhancement, industrial engineering, maintenance, cost reduction and legislative compliance. This first review reduced the number of projects to 67. The next stage in the evaluation process involved mapping risk and reward for the projects using a bubble diagram (Figure 6.8). This facilitated an examination of the overall balance of the portfolio and the panel agreed that the balance was satisfactory, with a few exceptions. The projects requiring a more detailed investigated were easily identifiable from the bubble diagram (for example numbers 39, 30, 64, 42 and 44). These were showing limited rewards and were incremental.

The sum of the costs for the 67 projects under review totalled $4.44 million. After consultation with senior management in the U.S., it was established that the technology acquisition budget for 1998 was limited to $1.5 million. A way to prioritise the projects into some rank order was required. Due to the limitations and questions raised during the 1997 project selection process, a decision was taken to adopt and test some of the latest portfolio management techniques. A number of portfolio methods used by other companies for new product project selection was examined for their potential to be applied to the prioritisation of MTA projects. This was achieved primarily by reviewing the latest books and literature on portfolio management (Cooper, Edgett, and Kleinschmidt, 1998; Rosenau, Griffen, Castellion, and Anschuetz, 1996).

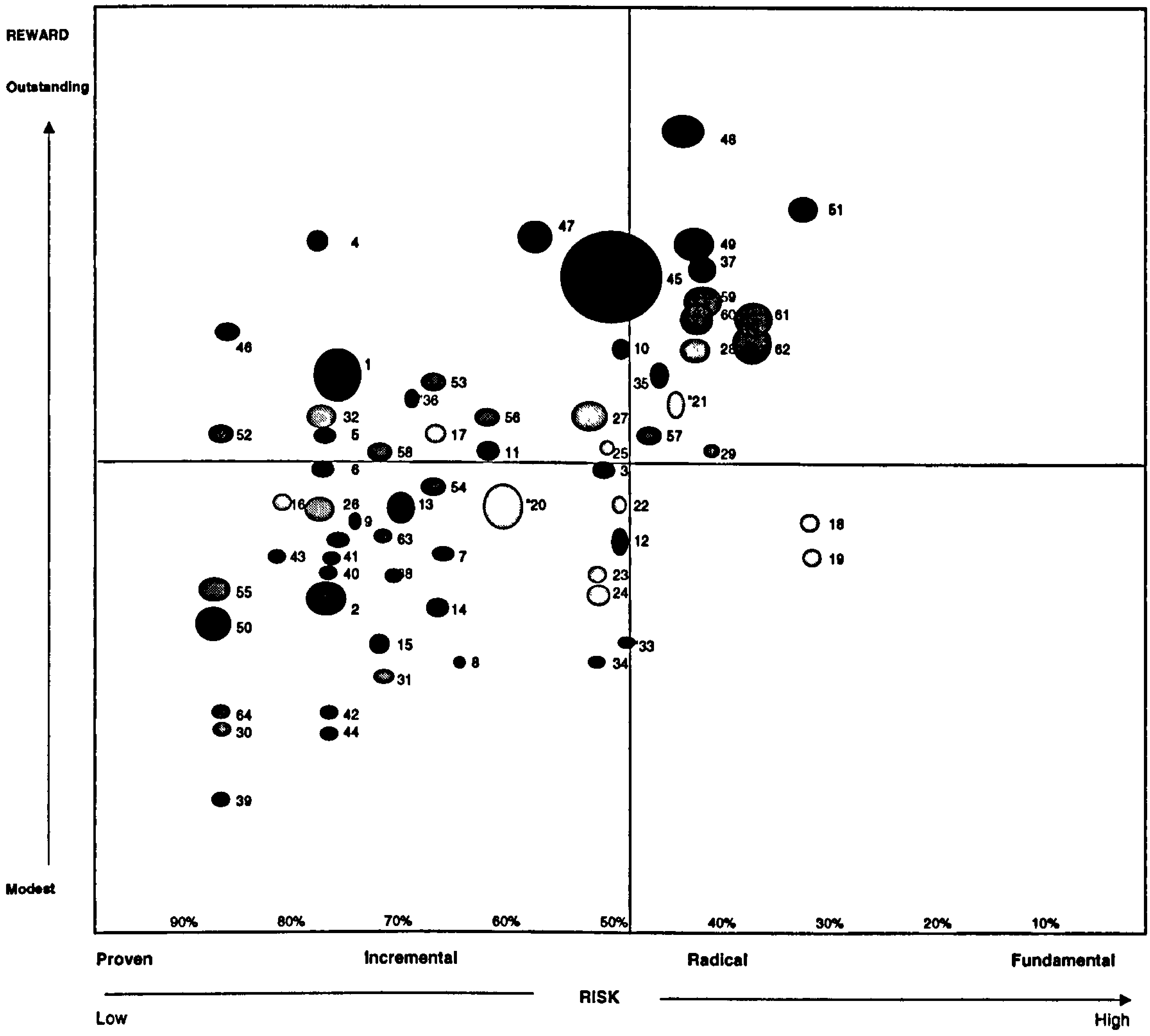

Figure 6.8: Risk versus Reward-1998 Project Proposals Portfolio. Note: The 1998 Bubble Diagram contains ellipses due to charting difficulties resulting from the number of projects; their shape has no significance.

6.5.1 Expected Commercial Value (ECV)

At just this time, Cooper, Edgett and Kleinschmidt (1997) described a formula known as the "Expected Commercial Value" (ECV) for selecting projects from a new product development portfolio. The ECV method was chosen for testing as it had the potential to be adapted for use in selecting manufacturing technology acquisition projects. This particular method was used by the English

China Clay Company of America (ECC International) for new product selection. This U.S. company produces clay and clay-related products and has a turnover of $4 billion. Cooper *et al* (1997)[3] describe this method as one of the more well thought out financial models. However, the formula for calculating the ECV was geared solely towards new products and included inputs such as probability of commercial success, product launch costs, and marketing costs. It was therefore not directly transferable to the field of manufacturing technology project selection.

The ECV method seeks to maximize the value or commercial worth of the portfolio, subject to certain budget constraints. This approach is based on a simple decision tree type analysis where the future stream of earnings from a project along with commercial and technical success probabilities and development costs are considered. More importantly, it incorporates the strategic importance of the project into the calculation with a high degree of weighting.

Classical NPV ignores risk, and most methods that include some assessment of risk are discredited as either too complex or unrealistic. ECV can be seen as a "cut-down" version of the decision tree method, and Cooper *et al* (1998) describe it as the most useful of the quantitative approaches.

The formula for calculating the expected commercial value is (Cooper *et al*, 1997):

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[3] The researcher was able to obtain an advance copy of Cooper *et al's* book, Portfolio Management for New Products, in 1997 before it went to general publication in 1998. This was made possible as the researcher's Company had contracted Cooper to hold an in-company seminar on NPD in mid-1997. It also presented a useful opportunity for the researcher to discuss portfolio application to MTA with Cooper.

$$\mathbf{ECV = (NPV*SI*P_{CS} - C)*P_{TS} - D}$$

where:

NPV = Net Present Value of ten year cash flow, after launch (none of the project costs – development, capital, etc – have been subtracted from this stream; this NPV is strictly the income stream).

SI = Strategic Importance Index. This has three levels depending upon the importance of the project (High=3, Medium=2, 1=Low).

P_{CS} = Probability of Commercial Success (from 0.2 to 1.00, in increments of 0.2 based on established criteria).

C = Commercialization (Launch) costs (capital costs, customer trials, marketing costs).

P_{TS} = Probability of Technical Success (from 0.2 to 1.00, in increments of 0.2 based on established criteria).

D = Development/ acquisition cost[4] (remaining in the project, for the first unit).

Having calculated the ECV for each project, the next step is to divide the ECV value by the development cost (D), which yields a ratio which English China Clay uses to rank product development projects.

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[4] This introduces the fairly well know idea that Sunk Costs should be ignored in decision making.

6.5.2 Expected Manufacturing Benefit (EMB)

The researcher decided to use the same logical constructs as the ECV model, but to change the inputs to those relevant to a manufacturing environment. It was also decided to change the name to "Expected Manufacturing Benefit" (EMB). The formula for calculating the Expected Manufacturing Benefit is:

$$\mathbf{EMB = (NPV*SI- C_A)*P_{TS} - D}$$

where:

NPV = Net Present Value of ten year cash flow based solely on the income stream. Development cost and outflows are not included.

SI = Strategic Importance Index. This has three levels depending upon the importance of the project (High=3, Medium=2, 1=Low).

C_A = Capital Costs to apply the project in multiple units and locations within all of manufacturing.

P_{TS} = Probability of Technical Success (based on established criteria).

D = Development/ acquisition cost[5] (remaining in the project, for the first unit)

Having calculated the EMB for each project, the EMB value is then divided the by the development costs (D), which yields a ratio which expresses the potential

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[5] In this case, the term acquisition is used if the technology is acquired from outside, whereas the term development refers to internal development by the R&D and/or Engineering departments of the Company

return on the development or acquisition investment. The projects are then rank ordered according to this ratio.

In the formula, the impact of "**Replication**" is considered in both the calculation of the NPV and in the capital costs to apply the technology in multiple units and locations (C_A).

The EMB analysis for the 1998 project proposals is shown in Tables 6.4, 6.5 & 6.6.[6]

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[6] It was necessary to present the table over three pages and three tables for readability purposes, as the spreadsheet used to generate the rank-ordered list of projects was quite large. Table 6.4 is the large spreadsheet, and tables 6.5 & 6.6 show the same spreadsheet divided into two sections.

Sorted By (1st) EMB/D + (2nd) HRA

R&D Phase -limited application

Expected Manufacturing Benefit (EMB)

Dept.	No.	Project	Est Project Cost (D)	Capex element	Est Savings / year	Prob Tech Success	Units Applied	Capex Applied	Est Savings / year	Payback (years)	Strategic Importance	NPV	EMB	EMB/D	HRA	Cumulative Cost (D)
			D			Pts		C			SI	NPV				
KNITTING	4	Rib Scanners	$2,016	$2,016	$2,880	0.90	36	$72,576	$103,680	0.70	3	$570,263	$1,308,554	649.05	A	$2,016
KNITTING	11	Auto splicing / knot-free on cones	$5,760	$5,760	$3,312	0.80	60	$345,600	$198,720	1.74	2	$1,275,317	$1,758,267	305.25	A	$7,776
SEWING	38	Sahl INS540 sewing feed system to 2N hem bottom machines	$11,520	$11,520	$6,048	0.90	40	$460,800	$241,920	1.90	3	$1,552,050	$3,346,944	290.53	A	$19,296
SEWING	48	Loader - Hem bottom machine (Jet Sew)	$50,000	$28,800	$96,480	0.45	20	$576,000	$1,929,600	0.30	2	$12,335,012	$10,935,961	218.72	A	$69,296
SEWING	37	Union Special 2N hem & close sleeve DNHS 2800	$56,160	$56,160	$126,720	0.80	10	$561,600	$1,267,200	0.44	2	$8,132,456	$9,365,827	166.77	B	$125,456
SEWING	36	JetSew Auto sleeve set machine 2800	$36,000	$36,000	$10,800	0.45	82	$2,952,000	$820,000	3.60	2	$5,262,479	$3,371,851	93.66	B	$161,456
SEWING	46	Schips HSC4J-3 attach binding & label to necks	$30,240	$30,240	$14,400	0.85	20	$604,800	$288,000	2.10	2	$1,293,631	$1,637,683	54.15	A	$191,696
CUTTING	31	Adjustable line - AMP	$6,000	$2,000	$1,200	0.75	40	$80,000	$40,000	2.00	2	$258,709	$319,069	53.18	A	$197,696
KNITTING	6	Cam trials + materials composition analysis	$20,000	$2,000	$600	0.80	200	$400,000	$120,000	3.33	2	$770,179	$892,190	44.61	A	$217,696
KNITTING	10	Design & materials on SJ yarn carriers	$17,280	$1,000	$1,200	0.50	200	$200,000	$240,000	0.83	1	$1,640,238	$652,839	37.78	A	$234,976
SEWING	35	JetSew 2N HSLT conversion kit 2860-1	$17,280	$17,280	$10,300	0.50	12	$207,360	$120,000	1.73	2	$770,179	$649,169	37.57	A	$252,256
SEWING	41	Sahl close leg machine - S.Pants	$33,120	$33,120	$63,360	0.80	2	$66,240	$126,720	0.52	2	$813,248	$1,215,080	36.69	B	$285,376
KNITTING	5	Sinker trials + material composition analysis	$20,000	$2,000	$500	0.80	200	$400,000	$100,000	4.00	2	$640,786	$686,856	34.34	A	$305,376
SEWING	43	Auto attach & topstitch zip - S.Shirt	$21,600	$21,600	$15,532	0.80	4	$86,400	$65,528	1.30	2	$428,594	$591,850	27.40	A	$326,976
SEWING	34	Union Special 2N HSLT conversion kit	$24,480	$24,480	$10,300	0.55	12	$293,760	$120,000	2.45	2	$770,179	$661,063	27.01	B	$351,456
SEWING	47	Loader - Attach cuff machine S.Shirt	$144,000	$28,800	$72,000	0.60	7	$201,600	$504,000	0.40	2	$3,234,499	$3,616,439	25.11	A	$495,456
SEWING	49	Loader - Sleeve machine S.Shirt	$144,000	$28,800	$90,000	0.45	7	$201,600	$630,000	0.32	2	$4,043,124	$3,404,092	23.64	A	$639,456
DYEING	15	Shore Rd Are monitoring system modules implemented	$14,400	$1,000	$1,000	0.85	20	$20,000	$20,000	1.00	3	$128,353	$295,900	20.55	A	$653,856
KNITTING	7	Needle trials	$20,000	$500	$250	0.75	200	$100,000	$50,000	2.00	2	$320,883	$386,325	19.32	A	$673,856
FINISHING	58	Bagging machine - 3 pack	$57,600	$57,600	$43,200	0.75	2	$115,200	$86,400	1.33	3	$554,498	$1,103,594	19.16	A	$731,456
SEWING	40	Juki Robotic close elastic machine- S.Pant	$40,320	$40,320	$35,000	0.80	1	$40,320	$35,000	1.15	3	$224,818	$466,507	11.57	D	$771,776
FINISHING	53	Heat seal logo positioning mechanism inc single ply strike	$28,800	$28,800	$5,700	0.70	6	$172,800	$34,200	5.05	3	$221,784	$316,007	10.97	A	$800,576
KNITTING	16	Load cells for exact web weight	$7,200	$7,200	$1,728	0.70	8	$57,600	$13,824	4.17	2	$88,716	$76,665	10.65	A	$807,776
KNITTING	8	Oil analysis	$1,440	$1,440	$1,200	0.80	3	$4,320	$3,600	1.20	1	$23,104	$13,587	9.44	A	$809,216
DYEING	17	Turning Pole for Jumbo webs	$43,200	$43,200	$42,000	0.70	2	$86,400	$80,000	1.08	1	$513,415	$255,709	5.92	A	$852,416
SEWING	44	Sahl 2N hem sleeves & bodies- open hem S.Shirt	$41,760	$41,760	$30,000	0.80	1	$41,760	$30,000	1.39	2	$192,530	$232,860	5.58	D	$894,176
DYEING	22	Continuous bleaching	$72,000	$43,200	$36,000	0.60	2	$86,400	$72,000	1.20	2	$462,071	$346,871	4.82	A	$966,176
FINISHING	54	Embroidery logo positioning mechanism	$28,800	$28,800	$13,800	0.55	6	$172,800	$64,800	2.67	1	$415,684	$129,075	4.48	A	$994,976
CUTTING	26	BRB system monitoring	$30,000	$10,000	$2,000	0.80	12	$120,000	$24,000	5.00	2	$164,024	$120,438	4.01	C	$1,024,976
FINISHING	59	Automated load/unload @ heat seal (Newcastle Univ)	$129,600	$43,200	$30,000	0.40	3	$129,600	$90,000	1.44	3	$577,582	$511,667	3.95	B	$1,154,576
FINISHING	64	Auto cage stock monitoring	$14,400	$14,400	$7,200	0.90	1	$14,400	$7,200	2.00	2	$46,207	$55,815	3.88	A	$1,168,976
FINISHING	52	Garment Compaction equipment (cartons)	$36,000	$36,000	$10,000	0.90	2	$72,000	$20,000	3.60	2	$128,353	$130,235	3.62	A	$1,204,976
KNITTING	3	Automated Creeling	$50,000	$1,500	$1,900	0.50	60	$90,000	$90,000	0.57	1	$377,589	$165,755	3.31	A	$1,254,976
OTHERS /	66	Real Time / Payroll system	$38,800	$0	$20,000	0.95	1	$0	$20,000	0.00	1	$128,363	$125,136	3.23	C	$1,293,776
CUTTING	32	WIP tracking (Oracle)	$50,000	$0	$20,000	0.80	1	$0	$20,000	0.00	2	$128,363	$155,365	3.11	C	$1,343,776
SEWING	39	Schips HSC1L-25 auto close shoulder - A.vest(2nd's)	$34,560	$34,560	$10,080	0.70	2	$69,120	$20,160	3.43	2	$129,380	$98,168	2.84	A	$1,378,336
KNITTING	2	Replace Hank Monitoring system	$182,880	$144,000	$28,800	0.75	2	$288,000	$57,600	5.00	3	$369,667	$432,848	2.37	A	$1,561,216
DYEING	20	Garment Dyeing Pilot Plant	$150,000	$100,000	$141,000	0.60	1	$100,000	$141,000	0.71	1	$904,890	$332,934	2.22	B	$1,711,216
SEWING	42	AAC 213 + modified stacker hem pkt + bottom - Open hem SP	$40,000	$40,000	$10,000	0.80	1	$40,000	$10,000	4.00	3	$84,177	$82,075	2.05	C	$1,751,216
FINISHING	60	Automated load / unload @ Amscomatic	$144,000	$45,000	$22,000	0.45	3	$135,000	$66,000	2.05	2	$423,565	$178,459	1.24	C	$1,895,216
SEWING	45	JetSew Sweatpant Assembly System	$648,000	$648,000	$250,000	0.50	1	$648,000	$250,000	2.59	2	$1,604,414	$632,414	0.98	C	$2,543,216
DYEING	24	Wet oxidation treatment (Beach Range)	$25,000	$20,000	$10,000	0.55	2	$40,000	$20,000	2.00	1	$128,363	$23,594	0.94	C	$2,568,216
CUTTING	28	Link cutting to Automatics machines	$72,000	$72,000	$15,000	0.45	12	$864,000	$180,000	4.80	1	$1,156,179	$66,000	0.92	C	$2,640,216
FINISHING	62	Robotic carton loading - retail	$216,000	$100,800	$43,000	0.40	2	$201,600	$86,000	2.34	2	$551,919	$144,695	0.67	C	$2,856,216
FINISHING	61	Robotic case-up	$216,000	$100,800	$43,000	0.40	2	$201,600	$86,000	2.34	2	$551,919	$144,695	0.67	C	$3,072,216
KNITTING	1	AGV's from Rabun for roll handling	$288,000	$200,000	$25,000	0.75	5	$1,000,000	$125,000	8.00	2	$802,207	$165,311	0.57	B	$3,360,216
CUTTING	29	Blade materials on BRB plates (life cycle) - Met Ins	$20,000	$4,000	$10,000	0.40	1	$4,000	$10,000	0.40	1	$84,177	$4,071	0.20	A	$3,380,216
DYEING	25	Low temperature dyeing	$5,000	$5,000	$2,500	0.50	1	$5,000	$2,500	2.00	1	$16,044	$522	0.10	B	$3,385,216
KNITTING	12	Mobile fabric inspection unit - camera	$20,000	$10,000	$1,500	0.56	2	$20,000	$3,000	6.67	3	$19,253	$767	0.04	A	$3,405,216
KNITTING	14	Knitting lapped fabric - rib	$10,000	$5,000	$1,000	0.56	8	$40,000	$8,000	5.00	1	$51,341	-$2,628	-0.26	C	$3,415,216
FINISHING	57	Auto carton erecting	$57,600	$57,600	$20,000	0.50	1	$57,600	$20,000	2.88	1	$126,353	-$22,224	-0.39	C	$3,472,816
SEWING	39	Pfaff oil free lockstitch machine - 1063	$2,160	$2,160	$450	0.90	2	$4,320	$900	4.80	1	$5,776	-$850	-0.39	A	$3,474,976
KNITTING	13	Automated cone return handling system	$100,000	$100,000	$20,000	0.70	2	$200,000	$40,000	5.00	1	$258,706	-$80,306	-0.80	C	$3,574,976
CUTTING	30	Plate storage and handling	$15,000	$10,000	$2,200	0.50	1	$10,000	$2,200	4.55	1	$14,119	-$11,293	-0.75	C	$3,589,976
FINISHING	63	Label application - conveyor line	$43,200	$28,800	$5,000	0.70	2	$57,600	$10,000	5.76	1	$64,177	-$38,586	-0.89	A	$3,633,176
OTHERS /	65	Technology Database - parameters and systems	$5,000	$0	$0	0.50	1	$0	$0	#DIV/0!	3	$0	-$5,000	-1.00	A	$3,638,176
OTHERS /	67	WIP Tracking / Oracle interface	$288,000	$0	$0	0.00	1	$0	$0	#DIV/0!	1	$0	-$288,000	-1.00	OFF	$3,926,176
KNITTING	6	Flat collar knitting machine trial	$7,200	$0	$0	0.70	1	$0	$0	#DIV/0!	1	$0	-$7,200	-1.00	OFF	$3,933,376
DYEING	18	Life Cycle Analysis (LCA)	$2,000	$0	$0	0.35	1	$0	$0	#DIV/0!	1	$0	-$2,000	-1.00	TBC	$3,935,376
DYEING	19	Bio-absorbent system to reduce environmental impact	$2,000	$0	$0	0.35	1	$0	$0	#DIV/0!	1	$0	-$2,000	-1.00	TBC	$3,937,376
DYEING	23	CO2 in place of organic acid	$36,000	$36,000	$39,938	0.55	1	$36,000	$39,938	0.90	1	$0	-$55,800	-1.55	TBC	$3,973,376
CUTTING	27	Link cutting to Compactors - Laser / Die	$72,000	$72,000	$10,000	0.55	12	$864,000	$120,000	7.20	1	$770,119	-$123,836	-1.72	TBC	$4,045,376
FINISHING	55	On line monitoring - Amscomatics + embroidery	$43,200	$43,200	$3,000	0.90	7	$302,400	$21,000	14.40	1	$134,771	-$194,066	-4.49	C	$4,088,576
DYEING	21	Combine cutting-finishing into single operator	$72,000	$72,000	$0	0.45	8	$576,000	$0	#DIV/0!	1	$0	-$331,200	-4.60	TBC	$4,160,576
FINISHING	56	Auto carton sealing - retail	$57,600	$57,600	$57,600	0.70	7	$403,200	$403,200	1.00	1	$0	-$339,840	-5.90	C	$4,218,176
SEWING	51	Automated Visual Inspection of Finished Garments (cameras)	$72,000	$72,000	$0	0.60	10	$720,000	$0	#DIV/0!	1	$0	-$504,000	-7.00	C	$4,290,176
SEWING	50	Automatics dept on-line machine monitoring system (99ind's)	$150,000	$120,000	$0	3.00	93	$8,600,000	$0	#DIV/0!	1	$0	-$8,970,000	-59.80	C	$4,440,176

Table 6.4: The rank-ordered list of project in the 1998 project portfolio based on EMB/D.

Sorted By (1st) EMB/D + (2nd) HRA *R&D Phase -limited application*

Dept.	*No.*	*Project*	*Est Project Cost (D)*	*Capex element*	*Est Savings / year*	*Prob Tech Success*
			D			Pts
KNITTING	4	Rib Scanners	$2,016	$2,016	$2,880	0.80
KNITTING	11	Auto splicing / knot-tie on creels	$5,760	$5,760	$3,312	0.80
SEWING	36	Sahl INS640 sewing feed system fo 2N hem bottom machines	$11,520	$11,520	$6,048	0.80
SEWING	48	Loader - Hem bottom machine (Jet Sew)	$50,000	$28,800	$96,480	0.45
SEWING	37	Union Special 2N hem & close sleeve DNHS 2800	$56,160	$56,160	$126,720	0.60
SEWING	35	JetSew Auto sleeve set machine 2300	$36,000	$36,000	$10,000	0.45
SEWING	46	Schips HSC4J -3 attach binding & label to necks	$30,240	$30,240	$14,400	0.85
CUTTING	31	Adjustable fins - AMP	$6,000	$2,000	$1,000	0.75
KNITTING	6	Cam trials + materials composition analysis	$20,000	$2,000	$600	0.80
KNITTING	10	Design & materials on SJ yarn carriers	$17,280	$1,000	$1,200	0.50
SEWING	33	JetSew 2N HSLT conversion kit 2660-1	$17,280	$17,280	$10,000	0.50
SEWING	41	Sahl close leg machine - S.Pants	$33,120	$33,120	$63,360	0.80
KNITTING	5	Sinker trials + material composition analysis	$20,000	$2,000	$500	0.80
SEWING	43	Auto attach & topstitch zip - S.Shirt	$21,600	$21,600	$16,632	0.80
SEWING	34	Union Special 2N HSLT converion kit	$24,480	$24,480	$10,000	0.55
SEWING	47	Loader - Attach cuff machine S.Shirt	$144,000	$28,800	$72,000	0.60
SEWING	49	Loader - Sleeve machine S.Shirt	$144,000	$28,800	$90,000	0.45
DYEING	16	Shore Rd Arel monitoring system modules implemented	$14,400	$1,000	$1,000	0.85
KNITTING	7	Needle trials	$20,000	$500	$250	0.75
FINISHING	58	Bagging machine - 3 pack	$57,600	$57,600	$43,200	0.75
SEWING	40	Juki Robotic close elastic machine- S.Pant	$40,320	$40,320	$35,000	0.80
FINISHING	53	Heat seal logo positioning mechanism inc single ply strike	$28,800	$28,800	$5,760	0.70
KNITTING	15	Load cells for exact web weight	$7,200	$7,200	$1,728	0.70
KNITTING	9	Oil analysis	$1,440	$1,440	$1,200	0.80
DYEING	17	Turning Pole for Jumbo webs	$43,200	$43,200	$40,000	0.70
SEWING	44	Sahl 2N hem sleeves & bodies- open hem S.Shirt	$41,760	$41,760	$30,000	0.80
DYEING	22	Continuous bleaching	$72,000	$43,200	$36,000	0.50
FINISHING	54	Embroidery logo positioning mechanism	$28,800	$28,800	$10,800	0.65
CUTTING	26	BRB system monitoring	$30,000	$10,000	$2,000	0.80
FINISHING	59	Automated load/unload @ heat seal (Newcastle Univs)	$129,600	$43,200	$30,000	0.40
FINISHING	64	Auto cage stock monitoring	$14,400	$14,400	$7,200	0.90
FINISHING	52	Garment Compaction equipment (cartons)	$36,000	$36,000	$10,000	0.90
KNITTING	3	Automated Creeling	$60,000	$1,000	$1,500	0.50
OTHERS /	66	Real Time / Payroll system	$28,800	$0	$20,000	0.95
CUTTING	32	WIP tracking (Oracle)	$50,000	$0	$20,000	0.80
SEWING	38	Schips HSC1I-25 auto dose shoulder - A-vest(2mc's)	$34,560	$34,560	$10,080	0.70
KNITTING	2	Replace Hank Monitoring system	$182,880	$144,000	$28,800	0.75
DYEING	20	Garment Dyeing Pilot Plant	$160,000	$100,000	$141,000	0.60
SEWING	42	AAC 213 + modified stacker hem pkt + bottom - Open hem SP	$40,000	$40,000	$10,000	0.80
FINISHING	60	Automated load / unload @ Amscomatic	$144,000	$45,000	$22,000	0.45
SEWING	45	JetSew Sweatpant Assembly System	$648,000	$648,000	$250,000	0.50
DYEING	24	Wet oxidation treatment (Bleach Range)	$25,000	$20,000	$10,000	0.55
CUTTING	28	Link cutting to Automatics machines	$72,000	$72,000	$15,000	0.45
FINISHING	62	Robotic carton loading - retail	$216,000	$100,800	$43,000	0.40
FINISHING	61	Robotic case-up	$216,000	$100,800	$43,000	0.40
KNITTING	1	AGV's from Rabun for roll handling	$288,000	$200,000	$25,000	0.75
CUTTING	29	Blade materials on BRB plates (life cycle) - Marline	$20,000	$4,000	$10,000	0.40
DYEING	25	Low temperature dyeing	$5,000	$5,000	$2,500	0.50
KNITTING	12	Mobile fabric inspection unit - camera	$20,000	$10,000	$1,500	0.55
KNITTING	14	Knitting lapped fabric - rib	$10,000	$5,000	$1,000	0.65
FINISHING	57	Auto carton erecting	$57,600	$57,600	$20,000	0.50
SEWING	39	Pfaff oil free lockstitch machine - 1053	$2,160	$2,160	$450	0.90
KNITTING	13	Automated cone return handling system	$100,000	$100,000	$20,000	0.70
CUTTING	30	Plate storage and handling	$15,000	$10,000	$2,200	0.90
FINISHING	63	Label application - conveyor line	$43,200	$28,800	$5,000	0.70
OTHERS /	65	Technology Database - parameters and systems	$5,000	$0	$0	0.00
OTHERS /	67	WIP Tracking / Oracle interface	$288,000	$0	$0	0.00
KNITTING	8	Flat collar knitting machine trial	$7,200	$0	$0	0.70
DYEING	18	Life Cycle Analysis (LCA)_	$2,000	$0	$0	0.35
DYEING	19	Bio-absorbent system to reduce environmental impact	$2,000	$0	$0	0.35
DYEING	23	CO2 in place of organic acid	$36,000	$36,000	$39,938	0.55
CUTTING	27	Link cutting to Compactors - Laser / Die	$72,000	$72,000	$10,000	0.55
FINISHING	55	On line monitoring - Amscomatics + embroidery	$43,200	$43,200	$3,000	0.90
DYEING	21	Combine cutting-finishing into single operation	$72,000	$72,000	$0	0.45
FINISHING	56	Auto carton sealing - revisit	$57,600	$57,600	$57,600	0.70
SEWING	51	Automated Visual Inspection of Finished Garments (cameras)	$72,000	$72,000	$0	0.50
SEWING	50	Automatics dept on-line machine monitoring system (98mc's)	$150,000	$100,000	$0	0.90

Table 6.5: The rank-ordered list of project in the 1998 project portfolio based on EMB/D (section 1).

Expected Manufacturing Benefit (EMB)

Units Applied	*Capex Applied*	*Est Savings / year*	*Payback (years)*	*Strategic Importance*	*NPV*	*EMB*	*EMB/D*	*HRA*	*Cumulative Cost (D)*
	C_i			SI	NPV				
36	$72,576	$103,680	0.70	3	$670,263	$1,308,554	649.08	A	$2,016
60	$345,600	$198,720	1.74	2	$1,275,317	$1,758,267	305.25	A	$7,776
40	$460,800	$241,920	1.90	3	$1,552,960	$3,346,944	290.53	A	$19,296
20	$576,000	$1,929,600	0.30	2	$12,383,512	$10,835,961	216.72	A	$69,296
10	$561,600	$1,267,200	0.44	2	$8,132,456	$9,365,827	166.77	B	$125,456
82	$2,952,000	$820,000	3.60	2	$6,262,479	$3,371,831	93.66	B	$181,456
20	$604,800	$288,000	2.10	2	$1,283,531	$1,637,683	54.16	A	$191,696
40	$80,000	$40,000	2.00	2	$256,706	$318,059	53.18	A	$197,696
200	$400,000	$120,000	3.33	2	$770,119	$892,190	44.61	A	$217,696
200	$200,000	$240,000	0.83	1	$1,540,238	$652,839	37.78	A	$234,976
12	$207,360	$120,000	1.73	2	$770,119	$649,159	37.57	A	$252,256
2	$36,240	$126,720	0.52	2	$813,246	$1,215,082	36.69	B	$285,376
200	$400,000	$100,000	4.00	2	$641,766	$886,820	34.34	A	$305,376
4	$86,400	$66,528	1.30	2	$426,594	$591,830	27.40	A	$328,976
12	$293,760	$120,000	2.45	2	$770,119	$881,083	27.01	B	$351,456
7	$201,600	$504,000	0.40	2	$3,234,499	$3,616,439	25.11	A	$495,456
7	$201,600	$630,000	0.32	2	$4,043,124	$3,404,092	23.64	A	$639,456
20	$20,000	$20,000	1.00	3	$128,353	$265,900	20.55	A	$653,856
200	$100,000	$50,000	2.00	2	$320,883	$386,325	19.32	A	$673,856
2	$115,200	$86,400	1.33	3	$554,486	$1,103,594	19.16	A	$731,456
1	$40,320	$35,000	1.15	3	$224,618	$466,507	11.57	B	$771,776
6	$172,800	$34,560	5.00	3	$221,704	$316,007	10.97	A	$800,576
8	$57,600	$13,824	4.17	2	$88,718	$76,685	10.65	A	$807,776
3	$4,320	$3,600	1.20	1	$23,104	$13,587	9.44	A	$809,216
2	$36,400	$90,000	1.08	1	$513,413	$255,709	5.92	A	$852,416
1	$41,760	$30,000	1.39	2	$192,530	$232,880	5.58	B	$894,176
2	$86,400	$72,000	1.20	2	$462,071	$346,871	4.82	A	$966,176
6	$172,800	$64,800	2.67	1	$415,584	$129,075	4.46	A	$994,976
12	$120,000	$24,000	5.00	2	$154,024	$120,436	4.01	C	$1,024,976
3	$129,600	$90,000	1.44	3	$577,559	$511,667	3.95	B	$1,154,576
1	$14,400	$7,200	2.00	2	$46,207	$55,813	3.88	A	$1,168,976
2	$72,000	$20,000	3.60	2	$128,353	$130,235	3.62	A	$1,234,976
60	$60,000	$90,000	0.67	1	$577,589	$198,795	3.31	A	$1,264,976
1	$0	$20,000	0.00	1	$128,359	$93,135	3.23	C	$1,293,776
1	$0	$20,000	0.00	2	$128,353	$155,365	3.11	C	$1,343,776
2	$69,120	$20,160	3.43	2	$129,380	$98,188	2.84	A	$1,378,336
2	$288,000	$57,600	5.00	3	$369,657	$432,848	2.37	A	$1,561,216
1	$100,000	$141,000	0.71	1	$904,890	$332,934	2.22	B	$1,711,216
1	$40,000	$10,000	4.00	3	$64,177	$82,025	2.05	C	$1,751,216
3	$135,000	$66,000	2.05	2	$423,565	$176,459	1.23	C	$1,895,216
1	$648,000	$250,000	2.59	2	$1,604,414	$632,414	0.98	C	$2,543,216
2	$40,000	$20,000	2.00	1	$128,353	$23,594	0.94	C	$2,568,216
12	$864,000	$180,000	4.80	1	$1,155,178	$59,030	0.82	C	$2,640,216
2	$201,600	$86,000	2.34	2	$551,919	$144,895	0.67	C	$2,856,216
2	$201,600	$86,000	2.34	2	$551,919	$144,895	0.67	C	$3,072,216
5	$1,000,000	$125,000	8.00	2	$802,207	$165,311	0.57	B	$3,360,216
1	$4,000	$10,000	0.40	1	$64,177	$4,071	0.20	A	$3,380,216
1	$5,000	$2,500	2.00	1	$16,044	$522	0.10	B	$3,385,216
2	$20,000	$3,000	6.67	3	$19,253	$767	0.04	A	$3,405,216
8	$40,000	$8,000	5.00	1	$51,341	-$2,628	-0.26	C	$3,415,216
1	$57,600	$20,000	2.88	1	$128,353	-$22,224	0.39	C	$3,472,816
2	$4,320	$900	4.80	1	$5,776	-$850	-0.39	A	$3,474,976
2	$200,000	$40,000	5.00	1	$256,706	-$60,306	-0.60	C	$3,574,976
1	$10,000	$2,200	4.55	1	$14,119	-$11,293	-0.75	C	$3,589,976
2	$57,600	$10,000	5.76	1	$64,177	-$38,596	0.89	A	$3,633,176
1	$0	$0	#DIV/0!	3	$0	-$5,000	-1.00	A	$3,638,176
1	$0	$0	#DIV/0!	1	$0	-$288,000	-1.00	OFF	$3,926,176
1	$0	$0	#DIV/0!	1	$0	-$7,200	-1.00	OFF	$3,933,376
1	$0	$0	#DIV/0!	1	$0	-$2,000	-1.00	TBC	$3,935,376
1	$0	$0	#DIV/0!	1	$0	-$2,000	-1.00	TBC	$3,937,376
1	$36,000	$39,938	0.90	1	$0	-$55,800	-1.55	TBC	$3,973,376
12	$864,000	$120,000	7.20	1	$770,119	-$123,535	-1.72	TBC	$4,045,376
7	$302,400	$21,000	14.40	1	$134,771	-$194,066	-4.49	C	$4,088,576
8	$576,000	$0	#DIV/0!	1	$0	-$331,200	-4.60	TBC	$4,160,576
7	$403,200	$403,200	1.00	1	$0	$339,840	-5.90	C	$4,218,176
10	$720,000	$0	#DIV/0!	1	$0	-$504,000	-7.00	C	$4,290,176
98	$9,800,000	$0	#DIV/0!	1	$0	-$8,970,000	-59.80	C	$4,440,176

Table 6.6 The rank-ordered list of project in the 1998 project portfolio based on EMB/D (section 2).

The list of projects for 1998 (Table 6.4) is sorted by EMB divided by development (D) or acquisition costs giving a ranked order of projects. In this case, the term "acquisition cost" is used if the technology is being acquired externally, for example, the purchasing of a machine direct from a supplier. The cut-off point for the projects occurs where the cumulative project costs reach the $1.5 million budget level. Through this sorting and ranking process, the project list was reduced to 36 projects from the original 67.

For each project, the estimated project cost and annual savings were established alongside the probability of technical success. In the acquisition of manufacturing technology, it is often the case that multiple units of the technology will be required across the manufacturing operations (Replication), and the potential for this is shown in the "Units Applied" column in Table 6.4. Thus, the capital cost to apply the technology across the organisation is included in the calculation of the EMB.

This ranking table was developed on a Microsoft Excel spreadsheet by the researcher, and allowed comparison of the rankings by any field. For example, when rank-ordered by NPV, a different portfolio of projects would be obtained than when rank ordered by EMB/D.

Before applying a technology Company-wide, it is now standard practice in the Company to develop or acquire the technology on a "one-off" or "test" basis and to fully trial the technology or equipment in a production environment for an extended period of time. Only after this production evaluation period is complete is the decision on full-scale implementation taken (this concept of "Replication" after initial piloting was discussed in section 6.4.2 previously). This two phase approach helps to reduce risk and limit the chances of investing in technologies that may not meet the desired operating requirements (output, quality, machine breakdown, etc.) of the Company.

The critical inputs of Strategic Importance (SI) and Probability of Technical Success (P_{TS}) are determined for each project by assessing the project against a predetermined set of evaluation criteria, as follows.

6.5.3 Strategic Importance (SI)

The Strategic Importance (SI) of the project to the company is one of the key inputs as it is the value used as a multiplier of the Net Present Value (NPV) of the project in the EMB calculation. The particular analytical model chosen for use by the company was adapted from a model used for NPD by Hoechst AG (Cooper *et al*, 1997). Strategic Importance is comprised of a number of distinct factors against which a value in the range from 1 to 10 is assigned. The total for each strategic element is calculated and a weighted average is determined to give a value for the strategic importance of the project.

The Strategic Importance ranges from 0 to 3, where:

1 = low strategic importance

2 = medium strategic importance

3 = high strategic importance

Table 6.7 shows how the SI value is determined using Project number 47 from the 1998 MTA project list as an example. It came out at 1.92, rounded up to 2. The SI is calculated by summing the scores for each factor (32) dividing by the maximum score possible (50), giving 0.64. This value is then multiplied 3 to express it in relation to the scoring range. This value was input to the spreadsheet developed by the researcher for calculating the EMB for project number 47.

Strategic Importance

Factors	1	4	7	10	
Congruence	Peripheral fit with business strategy	Modest fit	Good fit key element	Strong fit critical	7
Impact	Minimal impact	Moderate competitive impact	Significant impact difficult to recover if dropped	Future depends on programme	4
Proprietary Position	Easily copied	Protected but not a deterrent	Solidly protected patented	Unique to own organisation	4
Durability of the Technology	No distinct advantage	May get a few good years	Moderate life cycle	Long life cycle + continuous incremental improvements	7
Application Potential	one-off application	Limited potential for application	Moderate potential for application	Can be applied widely thru mft area	10
					1.92

Table 6.7: Strategic Importance assessment using Project Number 47 as an example (a Likert (1932) type scale is used i.e. 1 to 10).

6.5.4 Probability of Technical Success

The Probability of Technical Success (P_{TS}) is determined employing an approach similar to that used to establish the strategic importance value (and also from Cooper *et al*, 1997). Each project is gauged against a set of predefined technical factors or elements. A numeric rating is applied to each factor under consideration and these are then averaged to yield a value for the probability of technical success (in the range 0 to 1). This is then input into the calculation of the EMB for the project. An example is shown in Table 6.8, again using project number 47 as an example.

Probability of Technical Success

Factors	1	4	7	10	
Technical Gap	Large gulf between current practice and objective.	Major change	Step change	Incremental improvement engineering focus	6
Programme complexity	difficult to define many hurdles	easy to define many hurdles	A challennge but do-able	Straight forward	7
Technology Skill Base	Technology new to the company no skills	some knowledge but insufficient	selectively practiced	widely practiced	6
Availability of Resources	No appropriate people - must hire	Shortage in key areas	Limited resources available	Immediately available	6
Technological Maturity / Life Cycle	Embryonic	Growth	Mature	Ageing	5
					0.60

Table 6.8: Probability of Technical Success
using Project Number 47 as an example.

The probability value established here can also be used as an input to the risk versus reward bubble diagram for mapping purposes.

6.5.5 Outcome of the Selection Process - 1998

The 1998 project list (Table 6.4) along with the risk versus reward bubble diagram (Figure 6.8) were the primary tools used to review the projects, The review panel consisted of the same people as in previous years. At the first review meeting, the panel went through the ranked list (EMB/ D) project by project, reviewing the key parameters and discussing individual projects in some detail. The consensus was that the combination of the bubble diagram and the ranked order project list were of major value, and went a long way in addressing some of the problems encountered in previous years. However, the 1998 budget allocation of $1.5 million was higher than usual, and this in itself created a new problem - that of having limited human resources available to actually carry out all of the projects. This was a new constraint and the panel reacted to this situation by deciding to postpone the final decision until after a further review had taken place, which would take into account the resources required to execute the projects.

The term "do-able" was coined by the Vice President of Manufacturing to describe resource availability, and this was incorporated into the spreadsheet. Each project was rated on Human Resource Availability (HRA) rating using the following rating system:

A = Definitely feasible (do-able), resources available

B = Possibly feasible, resources may be available

C = Definitely not feasible, insufficient resources available

Projects were then sorted firstly on EMB/ D and then by HRA for ranking purposes. A second review meeting was held, and the project list was finalised based on the final ranked order of the projects having reviewed HRA (Table 6.4 includes a column "HRA").

Three examples of projects selected for the 1998 portfolio using the new EMB method are now discussed.

Project number 17 was selected, and involved the development of a "turning pole" for turning a length of sweatshirt fabric inside-out prior to the dyeing process. This was a collaborative project between FTL project engineers and a machine supplier company based in North Carolina, U.S.A. The machine operates by placing the continuous length of fabric over the pole using air suction, before reversing the direction of airflow, which pushes the fabric down inside the tube and out the exit tube (Figure 6.9).

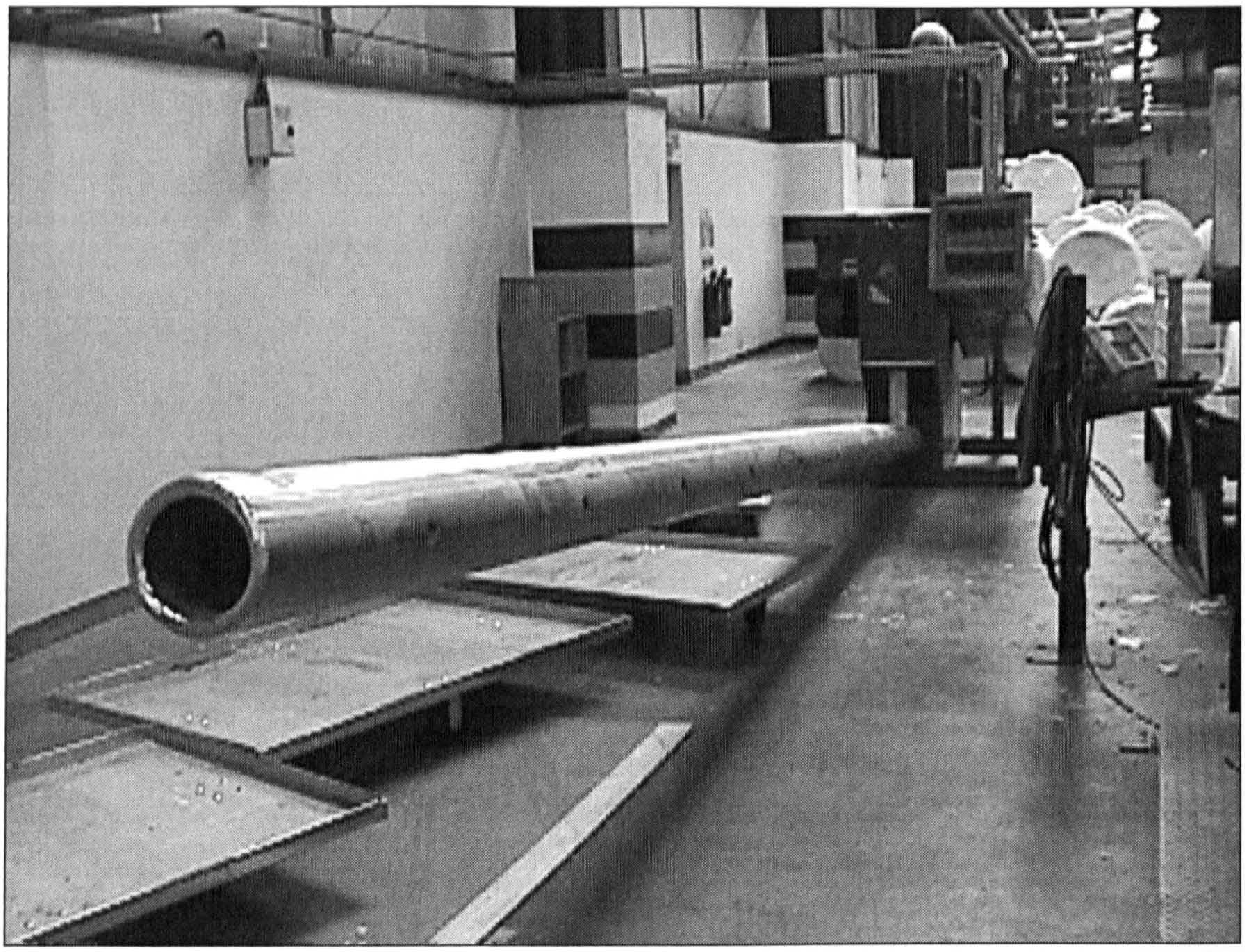

Figure 6.9 A "Turning pole" machine, which is used to turn fabric inside out in the dyeing plant.

Project number 58 was selected, and concerned the acquisition of an automated bagging machine for use in the final packaging of garments. The garments passed though a folding machine before entering the "unibagger" machine where a barcode label was attached and the plastic bag sealed automatically (Figure 6.10). This machine was purchased on a trial basis from a packaging company, Amscomatic, Inc., based in Atlanta, Georgia. The project was successful and a second unit was later purchased.

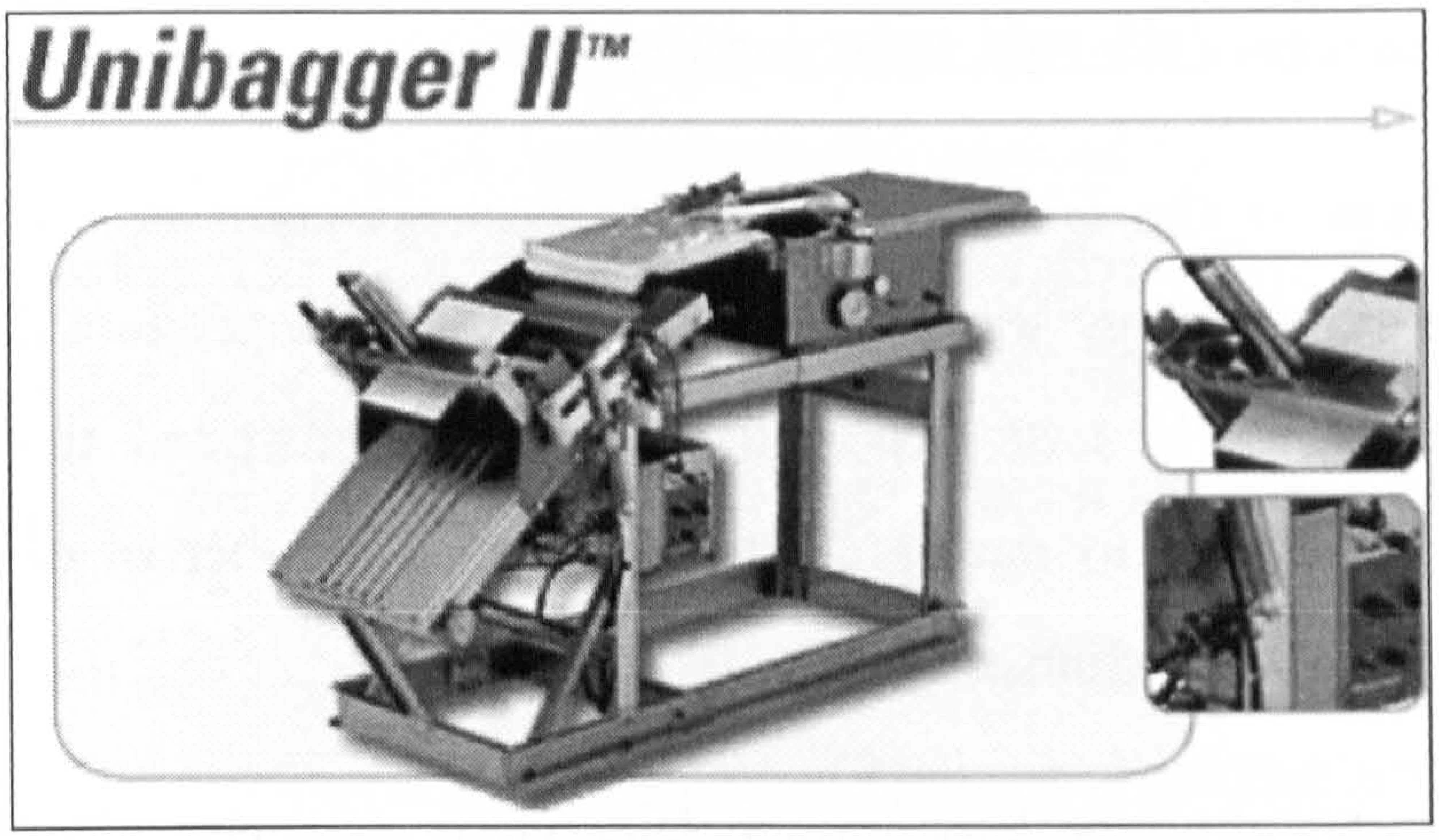

Figure 6.10: A bagging machine acquired for use in final packaging of garments in the Finishing Department.

Project number 48 had a high replication potential with the need for 40 units should the project succeed. This machine automatically loads and unloads Tee shirt body parts to a sewing machine designed to hem the waist of the garment (Figure 6.11).

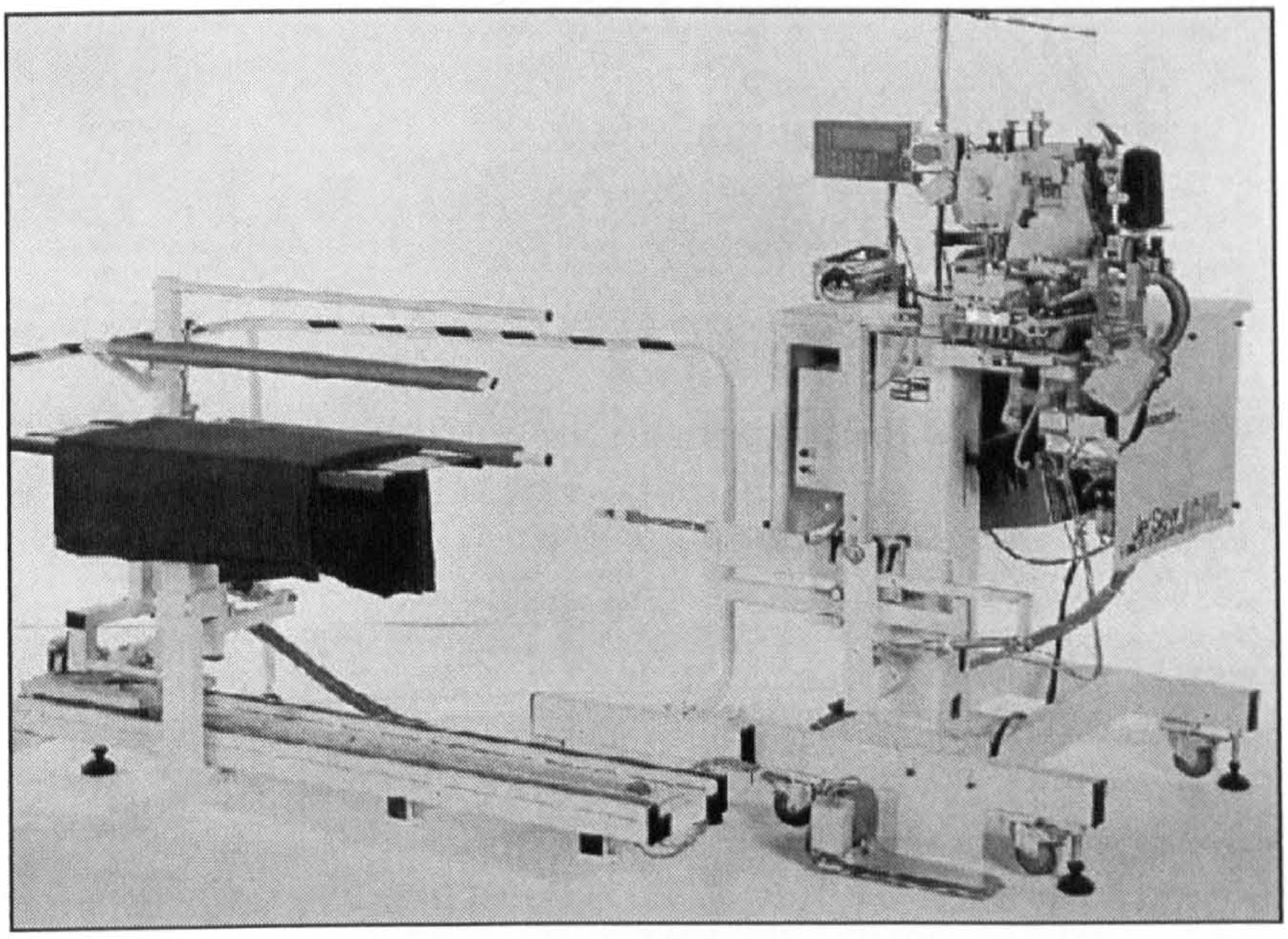

Figure 6.11: An automated load/ unload machine for the Jet Sew Bottom hemming sewing machine.

6.5.6 Discussion of the 1998 Selection Process

The application of the EMB model for project selection in the context of manufacturing technology acquisition as opposed to new product development proved successful. The case experience clearly demonstrated that the EMB method could be used to rank projects based on a number of objectives the Company wished to maximise.

The EMB model, although largely financially based, does consider the strategic importance of projects. It also recognises the issue of constrained resources (e.g. budget) and attempts to maximise the portfolio of projects in the light of this constraint. It also maximises the return per unit of finance invested in the acquisition by expressing the total project benefit (EMB) against the development (D) cost, yielding the ratio, EMB/D.

Closer examination of the EMB equation and the 1998 project table shows that the method will favour some types of projects more than others. In particular, in the context of MTA, it will favour projects characterised by: -

(1) high strategic importance

(2) high likelihood of success

(3) potential for wide application in manufacturing (Replication)

(4) low capital investment requirement

(5) low development or acquisition costs

One of the weaknesses of the method is its dependence on financial and other quantitative data. The more developmental the technology is or the earlier it is in its lifecycle, the less accurate this data is likely to be. In some of the 1998 projects, no hard data on estimated savings was available and this automatically had the effect of relegating the projects to the lower end of the list, even though their strategic importance was high. Another limitation of the EMB method is that it does not consider portfolio balance, for example, overall risk against reward. Thus, it should only be used in conjunction with bubble diagrams.

The EMB method did however prove useful in ranking the projects up to the budget limit of $1.5 million, and ensured that some of the previous project selection weaknesses (e.g. lack of strategic factors) in the Company were addressed.

6.6 Summary on Portfolio Methods

The use of Portfolio management methods was applied to the task of MTA project selection over three annual cycles. This case study has demonstrated that the application of selected tools and techniques can assist in the decision-making process. It was possible to select tools which consider the three high level goals of portfolio management - strategic direction, portfolio balance and maximising value - and to adapt them to the individual project selection requirements of the Company.

The first year of application, 1996, involved only limited use of portfolio methods in the form of the risk versus reward bubble diagram. Project risk was discussed for each project for the first time. The bubble diagram was modified to suit MTA specific terms, e.g. proven technology on the x-axis.

In the second year of trying out portfolio methods, 1997, some additional shortcomings of the methods were identified, including the absence of a formal consideration of the strategic importance of each project. Also, coloured bubbles were used to represent each manufacturing process area and this was useful as it enabled the review panel to see at a glance if a process area was under-represented in the portfolio.

The third annual cycle, 1998, was when many new and valuable concepts emerged and were tested out, including Strategic Importance, the probability of Technical Success, Replication, and EMB rank-ordering of projects in the portfolio. The issue of the availability of resources to undertake the projects also became an important consideration in the selection process. A spreadsheet was developed to assist in the project selection process, allowing sorting by any of the key input variables or resultant outputs. For example the projects might be sorted by rank-order on the calculation EMB/D.

6.7 Discussion

It proved possible to carry out the adapted methods in the context of MTA in the researcher's Company. The senior management team participated fully in the process over the three years, and the new methods gained acceptance. As the methods evolved over three annual cycles, new ideas came out of the process and were incorporated.

Although the methods and tools were in themselves extremely beneficial, the actual process of getting together and discussing and reviewing the portfolio of projects gave a whole new structure and discipline to the decision-making process. A wide variety of factors were considered, which ultimately led to the Company successfully allocating and spending its money on manufacturing technology.

A key aspect in the evolution of the MTA selection process was the concept of undertaking a trial of a single machine before deciding to replicate the technology, thereby reducing the risks associated with acquiring new technology. Prior to adopting this policy, the Company would have committed to the purchase of a number of machines from a supplier to avail of discounts for volume purchases, assuming that the external technology would work.

The EMB method is still heavily reliant on quantitative inputs such as NPV, but it offers a more rounded approach and the consideration of a greater number of factors when considering the choice of projects. The Risk versus Reward bubble diagram gives an overall view of balance of the portfolio at a glance. The other bubble diagrams available in NPD portfolio management e.g. familiarity of technologies and markets diagram, were deemed as being less applicable and beneficial, in the context of MTA selection.

ECV was not directly transferable to MTA and required significant adaptation as to what input variables should be used when determining the EMB formula, as the "commercial" input variables of ECV were not relevant.

Senior management in the Company was satisfied that the improvement in the selection process was of sufficient merit that the methods were formally adopted as policy for MTA by Fruit of the Loom, Europe.

The view of the review panel was that the techniques in themselves did not deliver a single "perfect" portfolio of MTA projects. However, there was a very strong consensus view amongst the panel that the improved portfolio selection methods, coupled with the more formal process, delivered a significantly superior selection process than existed previously. The added discipline of collective debate and discussion of the projects in a formal process setting was also a key ingredient.

As is evident from the research literature, the challenge of successfully selecting, acquiring and implementing manufacturing technology is a difficult one. Portfolio management techniques can add value and contribute to the selection phase of the MTA process, and enable optimal investment decisions to be made.

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Chapter 7

Case Study – A Single MTA Project: Jet Sew 5044 Automatic Loader Machine.

7.0 Introduction

So far acquisition has been studied at the level of projects in general. Portfolio selection, success factors and success measures have been studied. It was decided next to follow a single project all the way through from conception to finish to see how relevant and realistic these studies are at the single project level.

The project studied was the acceptance trials of a new machine intended to automate the feeding of tee shirt sleeves to an existing automatic sewing machine. The processes of selecting the project, trialling the machine in service and deciding whether or not to accept it for production, were all well documented as part of the normal factory procedures. The research study had three components:

1. two rounds of interviews were conducted with project participants - one shortly after arrival of the machine on the shop floor and one after the end of the project.

2. the project manager was asked to note detailed daily events and report to the researcher weekly.

3. after completion of the project, information was extracted from the standard project documentation.

The findings gave good support to the portfolio risk concept and to the success factors and success measures lists, as providing realistic and fairly complete management considerations. Some broadening of understanding of factors and measures emerged from the case and also a broader understanding of the meaning of project success or failure. In addition a wholly new area of consideration emerged, which was the impact of corporate strategy changes on the success or failure of a project.

This project was selected for a detailed case study simply because the timing of this acquisition coincided with this phase of the research work.

7.1. A Summary of the Project History

The machine was acquired from a supplier of textile machinery on a trial basis, to be accepted and paid for only if it met the factory's performance criteria. The concept of the machine had quite a long history, but only a few examples had been implemented, apparently successfully, in other factories in the industry. The machine arrived in FTL's factory in May 1998 and underwent operational trials until September 1998. When interviews were conducted in July 1998, there was a general feeling that the project was going to be successful, but in November 1998 a formal decision had to be made to terminate trials and not accept the machine. The reason was that it had suffered from multiple breakdowns and was clearly not going to achieve a satisfactory standard of operation.

Meanwhile in September 1998 a major manufacturing strategy change had been ordered for the Irish operations by the Parent Company. One consequence was that automation of manual operations such as sewing would soon cease, in favour of moving manufacture to a low labour-cost country. Another consequence was the adoption of the modular manufacturing philosophy in

FTL in place of the mass production line philosophy. Either of these strategic changes on their own would have meant that the project would have been terminated even if it had succeeded technically. A summary of key events surrounding this project is given in table 7.1 below.

Key events occurring during project lifecycle	**Date**
Project selected from 1997 Portfolio	October 1996
Purchase order raised	October 1997
Interviews with machine supplier representatives in Barneveld, New York State, U.S.A.	*April 1998*
Machine arrives at factory in Ireland and is commissioned by Jet Sew Technician.	May 1998
Machine trial starts	June 1998
1st series of interviews with project team (on-site)	*early July 1998*
Visit by U.S. CEO (Bill Farley) and other U.S. Senior Management Team to announce change in strategy.	week 2, September 1998
Strategic change announced (1) all sewing facilities to convert from mass production line assembly process to team (cell) based process, incorporating Kaizen manufacturing principles.	September 1998
Strategic change announced (2) closure of all remaining sewing operations in Ireland (6 factories) and operations relocated offshore (Morocco).	September 1998
Project trial ends	week 4, September 1998
Decision taken to terminate project	November 1998
2nd series of interviews with project team	*February 2000*

Table 7.1: Timeline of key events during Project lifecycle. Research actions are shown in italic.

7.2 Background to the Project

In 1994, the Fruit of the Loom Manufacturing Company in Ireland made a strategic decision to invest significantly in automated sewing technologies as a means to further reduce its manufacturing cost base to enable it to compete with products originating from lower-cost regions, such as North Africa and the Far-East. During the same period, the Parent Company in the U.S. were also investing heavily in automated technology for similar competitive reasons, but also to try and sustain many jobs in their U.S. sewing plants.

At the same time, sewing machine manufacturers throughout the world were working to keep up with the demand for automated sewing equipment. The major equipment manufacturers were mainly based in Japan, the U.S.A. and Germany. The larger suppliers included companies like Juki, Union Special, Pfaff and Singer. However, many new small automation specialists were emerging in the U.S. to fill niche market gaps that existed at the time including companies like Atlanta Attachment Company, Sahl AG, and Tice Engineering. These companies tended to specialise in developing highly automated machinery for a particular segment of the industry, for example, tee shirt manufacturing.

Fruit of the Loom's main global competitors, Sara Lee and Russell Corporation, were also pursuing similar strategies in terms of sewing technology investment, so Fruit of the Loom were in step with what was happening generally in the industry.

In the period 1994 through to 1998, FTL Ireland invested $8.5 million in automated sewing technology, and had to create a special manufacturing unit to facilitate these technology acquisitions. At one stage, up to 130 people were employed in this department alone, working on a three shift system 24 hours per day to maximise return on this capital investment.

7.3 Project Description

The Loader project first appeared on the Company's 1996 R&D project list. Technology scanning efforts by the R&D department had identified that a machine for loading tee shirt sleeves to an automatic sewing machine was under development by Jet Sew Technologies, Inc. in the U.S. This task was being performed manually in the manufacturing plants at this time. Contact was initially made with this company in 1995 at which time the feasibility of the project was discussed. The machine was still under development, but Jet Sew believed that the machine would be available to customers during 1996, so it was put onto FTL's 1996 R&D project list. However, during the course of 1996, it was established through further communication with Jet Sew that the machine would not be available until 1997 due to development problems.

In the third quarter of 1996, the 1997 R&D project list was being drafted and due to the attractive payback for this project, it was carried over and put on to the 1997 project list as shown in Table 7.2. The projects were also mapped using a bubble diagram illustrating risk versus reward as in 1997 the Company used portfolio analysis for the first time (Figure 7.1). The automatic loader project is highlighted in this bubble diagram and is shown as project number 21.

By early 1997, FTL had twelve automated AAC 411 Hem & Close Sleeve sewing machines in its automatics department, and therefore the viability of using automatic loaders to feed them was now even more attractive. These AAC411 machines were operating 24 hours per day, 5 days per week on a rotating three-shift basis. Each machine required one person to operate it, whose primary role was to manually position and align the cut tee shirt sleeves onto a conveyor, which in turn fed the sleeves into the machine, which sewed them automatically. This is illustrated in Figures 7.2, 7.3 and 7.4.

The purpose of the Jet Sew Automatic Loader was to eliminate this manual job by automatically feeding sleeves to the AAC 411 machine from cut stacks, positioned on an indexing conveyor. Apart from alleviating this mundane, repetitive job, there would be significant opportunities to reduce labour costs by having one operator work multiple sewing machines. The ratio was envisaged as being one operator per 3 or 4 machines at the outset of the project compared to the one to one ratio that existed in 1997. With 12 AAC 411 machines in operation over three shifts, this meant that the number of direct operators would decrease from 36 to 12, or possibly even as low as 9.

Project No.	**Project**	**Project Cost**	**Annual Savings**	**Payback Years**
1	Packing Line Control Mods	$20,000	$11,000	1.82
2	Automated Bale Opener	$150,000	$72,000	2.08
3	Fabric Inspection machine	$30,000	$10,000	3.00
4	Fabric Coding System	$48,750	$31,000	1.57
5	High Frame machines	$150,000	$123,000	1.22
6	BDM Project	$90,000	$85,000	1.06
7	Filter Flow 2000	$15,000	$120,000	0.13
8	Lint Catcher	$7,000	$8,000	0.88
9	Fabric Unrolling machine	$30,000	$40,000	0.75
10	Garment Dyeing	$100,000	$141,000	0.71
11	Low Temperature Dyeing	$50,000	$40,000	1.25
12	Wet Oxidation	$42,000	$30,000	1.40
13	Pad Detwister	$60,000	$71,500	0.84
14	Dye Jet Controls	$39,000	$26,000	1.50
15	Data Collection System	$75,000	$46,000	1.63
16	BRB Plates	$31,000	$9,000	3.44
17	Auto Band Leg	$30,000	$56,000	0.54
18	Auto Close Leg	$32,000	$59,000	0.54
19	Auto Hemmer Seamer	$75,000	$180,000	0.42
20	Auto Bottom Hemmer	$55,000	$136,000	0.40
21	**Jet Sew Auto Loader**	**$85,000**	**$72,000**	**1.18**
22	Combined 2N	$22,000	$64,000	0.34
23	211E	$37,500	$13,000	2.88
24	266T	$39,000	$12,500	3.12
25	HP for QC	$50,000	$20,000	2.50
26	HSLT Conversion	$71,000	$80,000	0.89
27	Auto Fold machine	$60,000	$70,000	0.86
28	Auto Pallet machine	$80,000	$90,000	0.89
	Total	$1,574,250	$1,716,000	0.92

Table 7.2: 1997 R&D Project List, with Jet Sew Auto Loader Machine Project highlighted. Payback was calculated at 1.18 years.

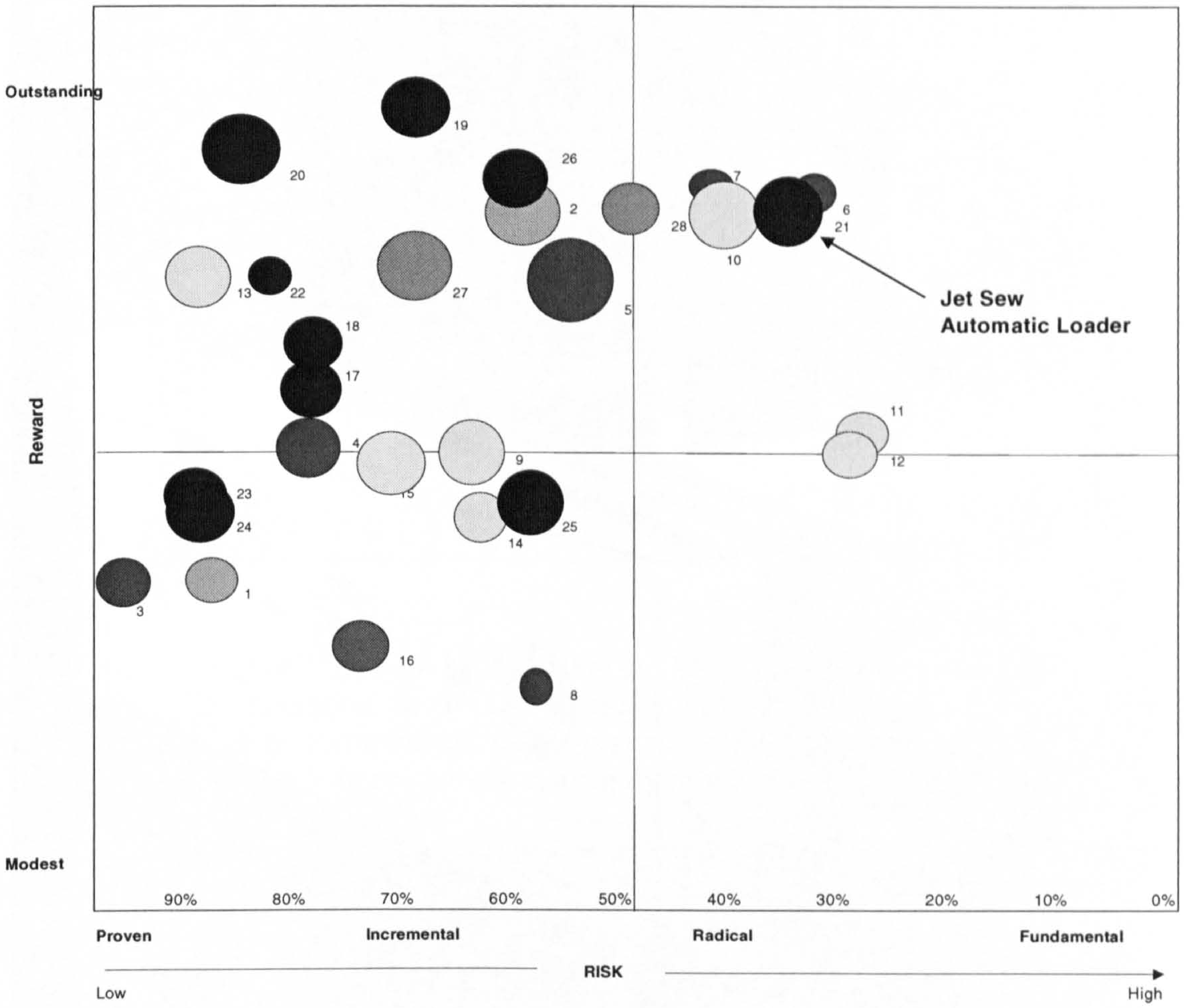

Figure 7.1: Bubble Diagram showing Risk versus Reward for 1997 Selected R&D Projects Portfolio. Jet Sew Automatic Loader project is clearly indicated. The different shades represent different manufacturing process areas.

The portfolio bubble diagram of figure 7.1 shows the assessment of risk versus reward for the project list in Table 7.2. As can be seen, Project 21 – the Jet Sew Auto Loader – was viewed as being a fairly high-risk project with only a 30-40% chance of succeeding. However, the Reward axis indicated it to be a very attractive project, with the potential reward being close to "outstanding" on the scale. The area of the bubble reflects the project cost. The greater the cost, the larger the area of the bubble.

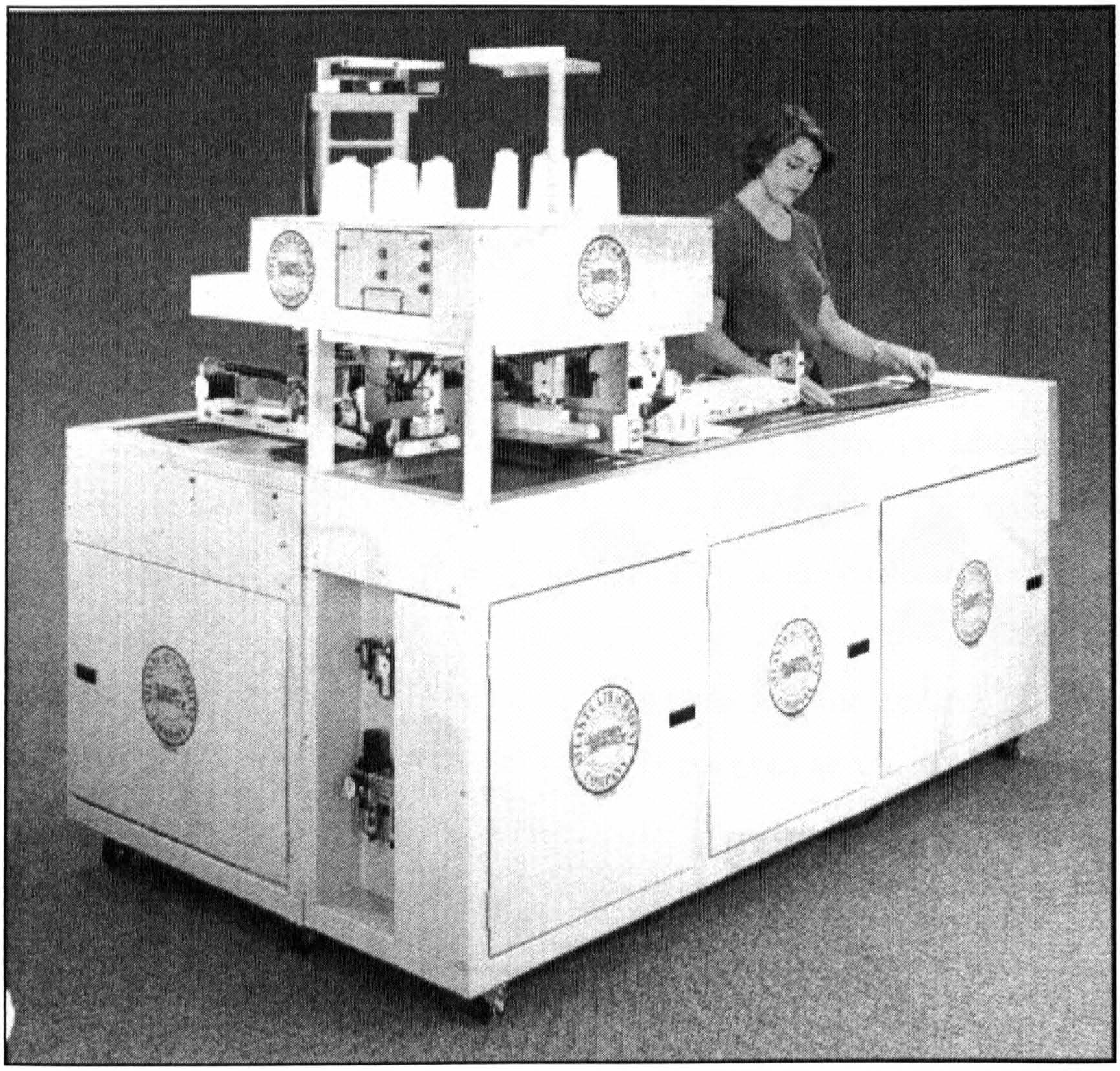

Figure 7.2: The AAC 411 Hem & Close Sleeve machine, showing the manual loading of individual tee shirt sleeves onto the conveyor section of the machine. The idea was to link the Jet Sew Loader to this machine for feeding in sleeves.

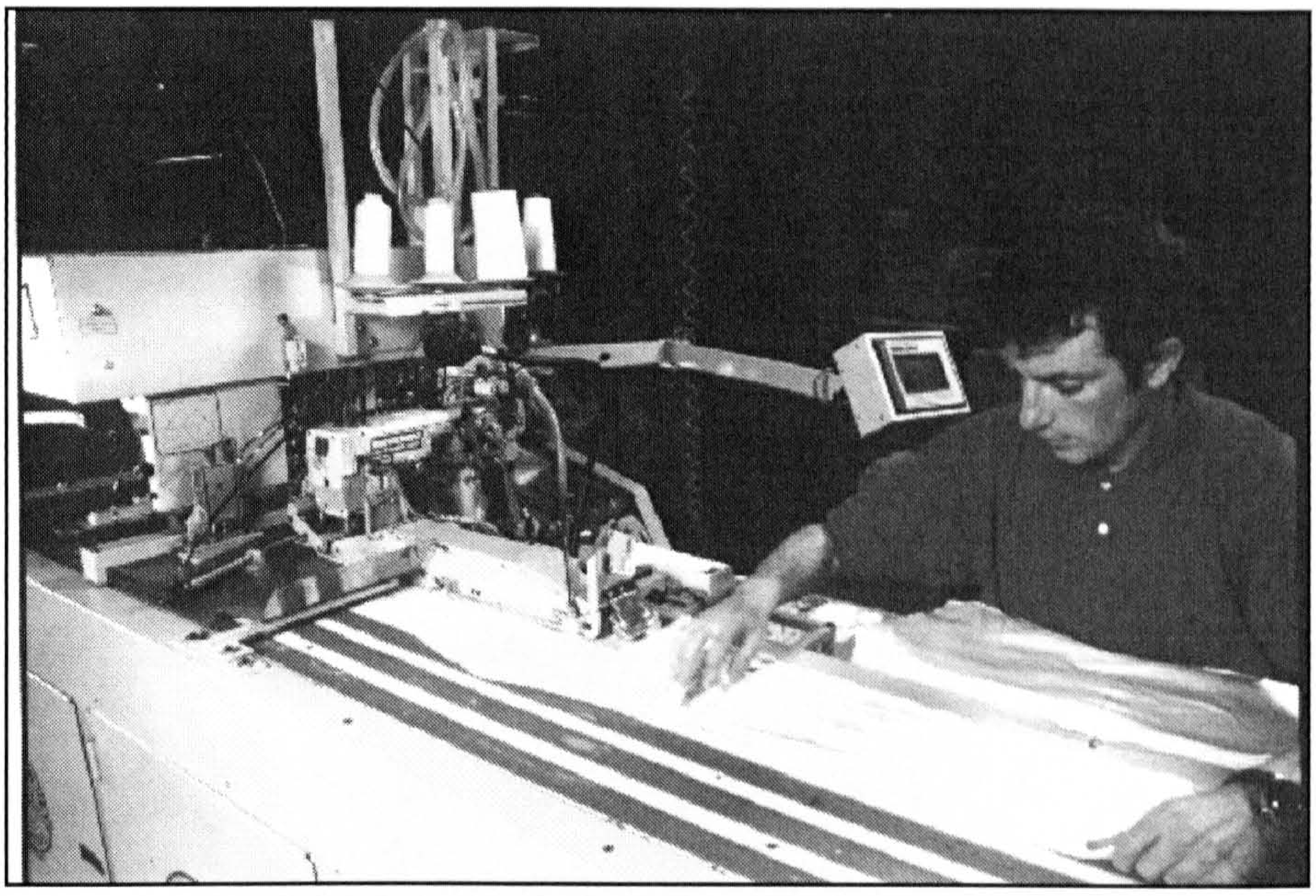

Figure 7.3: The AAC 411 Hem & Close Sleeve sewing machine in operation in FTL's automatic sewing department. The operator lifts the cut sleeve part from the stack, aligns it then loads it onto the conveyor, a highly repetitive task

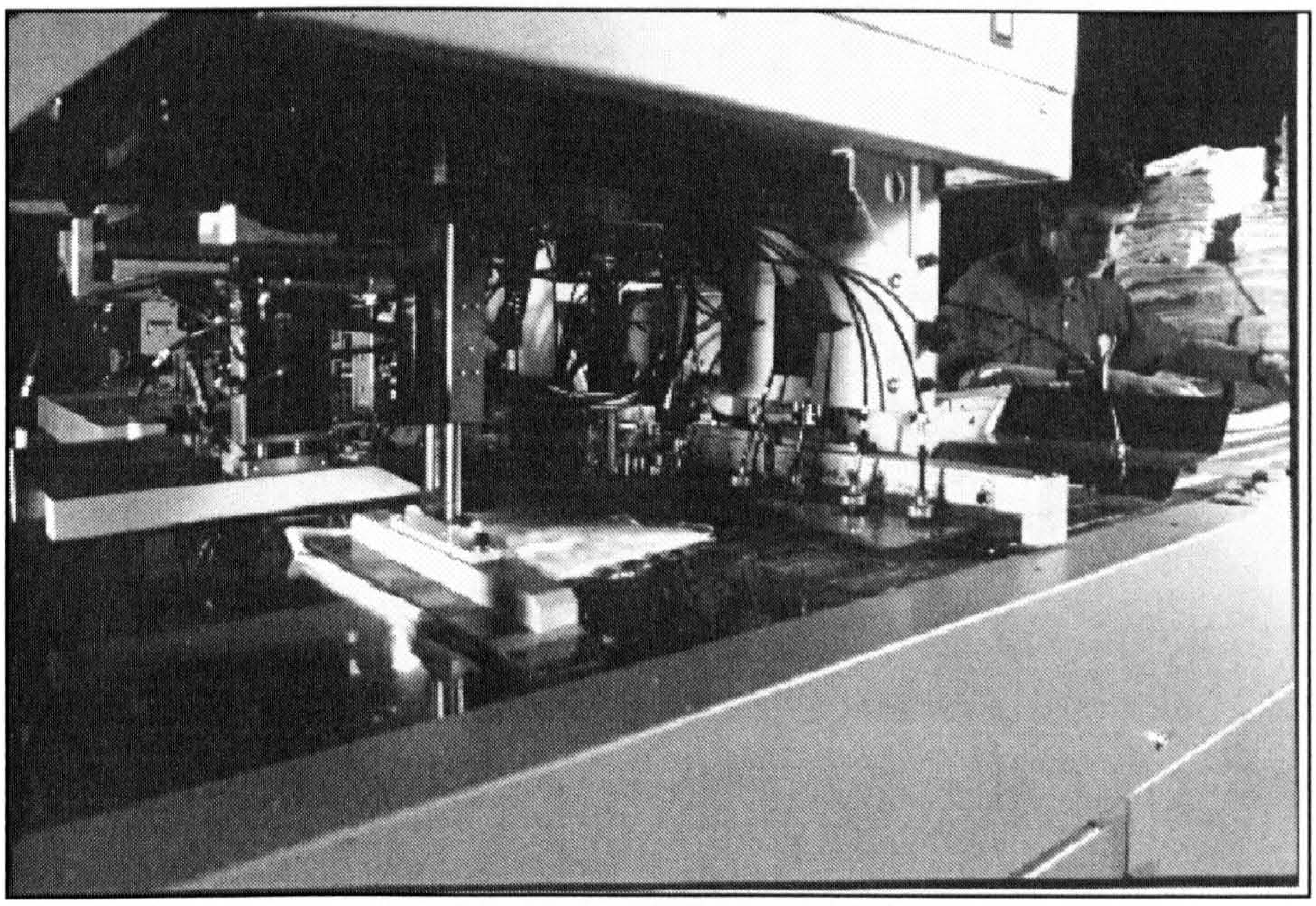

Figure 7.4: The AAC 411 Hem & Close Sleeve machine in operation, showing the part of the machine designed to lift, fold and turn the sleeve before feeding it into the next automated sewing machine head.

The first official task recorded for this project was dated the 5th June 1997 when a FTL sewing Project Engineer visited the International Machine Show in Cologne, Germany. He met with the president of Jet Sew to discuss initial project plans and timelines. The machine FTL Ireland was purchasing is shown in Figure 7.5.

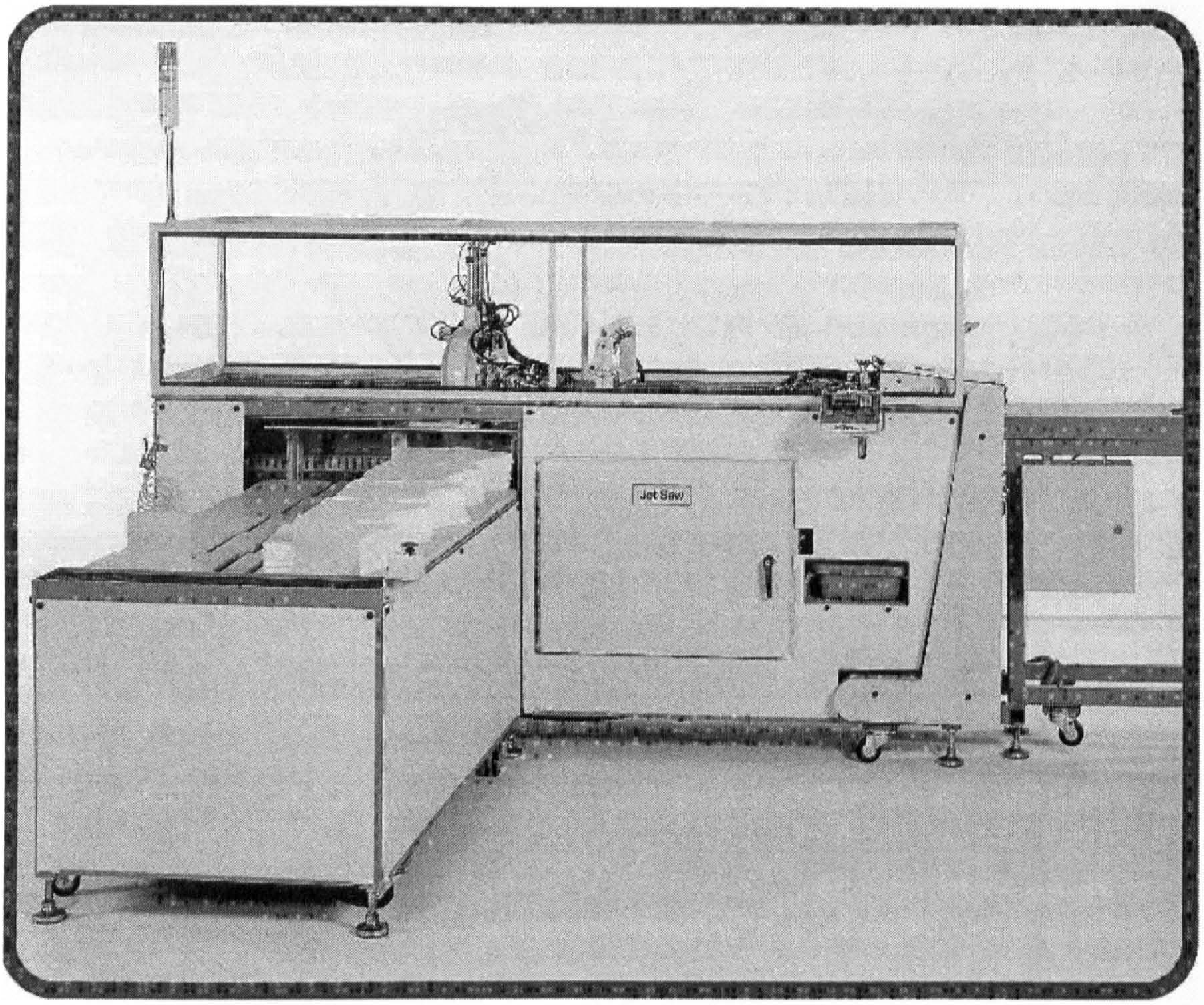

Figure 7.5: The Jet Sew 5044 Automated Sleeve Loader machine purchased by FTL Ireland. The photograph shows cut sleeve parts moving along an indexing conveyor before entering a picking section where individual sleeve parts are picked from the stack, passed through an aligning device and then fed to an exit conveyor before entering the AAC411 sewing machine.

7.4 Brief history of the Supplier Company, Jet Sew Technologies, Inc.

Jet Sew Technologies, Inc. was established in Barneveld, New York in July 1959 and was owned jointly by John Rockerath and Harold Schreck until March 1976 when it was sold to Cluett, Peabody & Company, a publicly owned company. From 1986 through to 1993, West Point Pepperell, Inc. owned the company and from 1993 to the present, it has been a wholly owned subsidiary of Union Underwear, Inc.

At the time of this project, the company employed around 120 people and its president was Ernst Schramayr. It has over the years specialised in developing and selling automated sewing technology for the apparel and textile industry. In recent years, their focus has shifted more towards textile equipment automation (towels, sheets, etc) due to the movement of labour intensive sewing jobs to lower cost countries in Central America.

7.5 Development History of the Automatic Sleeve Loader before FTL Ireland Plant Trial

The project was first started in the early 1990's as part of a collaborative development effort between North Carolina State University (NCSU), Ark Machinery Company, the Defence Logistics Agency (DLA), and Jet Sew Technologies. One of the responsibilities of the DLA was to acquire all the uniforms for the U.S. Military and they had identified the need for a machine which could pick cut cloth pieces and separate them before feeding them into another machine for assembly. They contracted NCSU to develop a "proof of concept machine" which was built by Ark Machinery. Jet Sew were asked to join the project because of their expertise in handling and sewing fabric using automation technology. The project was successful in that the machine was able to perform the basic task of picking up garment parts, but neither Jet Sew nor Ark Machinery Company commercially exploited the development.

In 1993, Jet Sew had been visiting FTL sewing plants in the U.S. and had identified the need for a machine that could automatically load the automated sleeve machines that were used extensively in sewing at the time. These automated hem and close sleeve machines were manufactured by Union Special and the model in use was known as the HSLT2 2800 machine. Jet Sew took the concept used in the DLA project and developed it further so that it could be used to feed these HSLT2 2800 model machines.

It was first field-tested in a Fruit of the Loom sewing plant in Martin Mills, Louisiana in 1994 and then taken back to Jet Sew for redesign and modifications. It went back into production for an extended trial period of three months in the plant. Jet Sew viewed this trial as being successful and importantly they believed that they had a model that could be exploited commercially. They were satisfied that the economic justification criteria necessary for such an investment by apparel companies could be achieved. The payback period was established to be around 14 months, which would be attractive to most companies.

By early 1996, Jet Sew had a machine that they believed could be marketed and sold to FTL. They had tooled-up their manufacturing plant and ordered sufficient parts to manufacture a first production run of five of these machines. They manufactured five machines in anticipation of securing an order from FTL U.S. However, FTL in the U.S. was in the midst of changing its manufacturing strategy and had embarked on a major programme to move sewing jobs to Central America. As a result of this revised strategy, the demand for the automated loaders disappeared, as the low labour costs off-shore would make their payback significantly longer. It was also the opinion of FTL that the technical support staff necessary to maintain automated machines would not be readily available in Mexico, Honduras and El Salvador. Between late 1995 and the end of 1998, FTL had moved 18,000 sewing jobs to Central America and closed all but a few of its U.S. sewing facilities.

This left Jet Sew in a dilemma. They now had to find another customer for their machines; they had some machines already built and they had the raw material inventory in-house to manufacture additional machines. Bassett-Walker, an apparel company who are part of the VF Corporation had expressed an interest in the machine at a trade show in Atlanta, and so they were approached as a possible customer. They were interested in the machine and in 1996, they sent an automated sewing machine to Jet Sew's facility to be connected to the automatic sleeve loader. This in itself presented some technical challenges for Jet Sew as the sewing machine was a Japanese-made Pegasus machine, which Jet Sew had never before coupled to their machine. Nevertheless, they were able to link the machines together and the combined system was sent into a Bassett-Walker plant for production trials that ran through 1997. On completion of the trials, Bassett-Walker actually purchased two machines in 1997.

When FTL Ireland started their project in June 1997, these two Loader machines were known to be in operation in a Basset-Walker sewing plant in North Carolina. At this time too, Jet Sew were actively marketing the machine at trade shows and in textile publications. Their official brochure on the Loader machine is show in Appendix G (i). The first model on offer to customers was model 5043. However, the model acquired for testing by FTL Ireland was model 5044, which had further enhancements and which was designed to be integrated with the AAC 411 machine, as opposed to the Pegasus machine for which the model 5043 was designed.

Further information on the development history of the Auto Loader machine is given in the transcriptions of interviews with the President of Jet Sew and the Auto Loader machine Programme Manager in Appendix G (ii).

7.6 The Case made for undertaking the Auto Loader Project

All MTA and R&D projects within FTL manufacturing require the completion of a standard project submission form. This form gives details on the project including:

- Project title
- Project manager
- Type of project
- Description and objectives
- Duration
- Milestones
- Resources & team
- Type of innovation
- Risk assessment
- Product impact
- Patenting potential
- Cost benefit analysis

The actual project submission form for the Jet Sew Loader project is shown in Appendix G (iii).

7.6.1 Project Team & Member Profile

As is the case with all R&D projects in the Company, a project team was formed after acceptance of the proposal to undertake the project and was selected jointly by R&D and manufacturing management. The project team and a brief profile on each of the members are given below:

Catriona Kelly, Manufacturing Technology Development Manager – a mechanical engineering graduate and chartered engineer, she had joined FTL in 1992 as an R&D engineer, having previously worked for Bombardier Aerospace and the Takata Corporation of Japan, automotive component manufacturers. She was appointed head of the R&D and the Manufacturing Technology Development (MTD) department in 1996. She has experience of managing multiple technology acquisition projects simultaneously across all manufacturing areas and is well versed in project management tools and techniques.

Mark Baldrick, Project Engineer, Sewing – a business studies graduate and qualified industrial engineer, Mark joined FTL from another clothing manufacturer in 1993 as an industrial engineer. He has been responsible for most of the projects involving the acquisition of automated sewing technology for the firm and this was his tenth project as the main project engineer. His responsibilities in relation to this project were to plan, control and execute the project in all aspects - essentially he was the project manager. He reports to the MTD manager, Catriona Kelly.

Joe Mullan, Operations Manager – with a background in business studies and industrial engineering, Joe joined FTL in 1989 as industrial engineering manager and had progressed to the position of operations manager by 1996 with responsibility for all sewing operations in Ireland and Morocco, with approximately 1,600 people.

Mickey Donaghey, Supervisor, Automatics Department – Mickey has the responsibility for managing the Automatics department. He has over fourteen years experience working in various roles and departments within FTL. He has been a Supervisor in this department for three years.

Sammy Wilson, Head Automation Engineer – with over 20 years experience on sewing machine engineering and maintenance and has worked for seven years with FTL. He has specialist knowledge in automated sewing technology including PLC's, sensors, and electronic circuits, and is also responsible for Mechanic Training and Development.

Owen Doherty, Sewing Mechanic – with ten years experience in FTL, having started as an apprentice. He is responsible for machine repair and maintenance in the automated sewing department.

Gary O'Donahue, Operator – assigned as machine operator during the trial period. Gary has worked in the department operating other automated machines for three years.

Mark Kilmartin, Quality Engineer – seconded to project team for duration of the project. A young graduate with four years experience in the Quality Assurance department.

The above listing is the core project team, but other personnel were also involved in the project on a peripheral basis, for example, Health and Safety and Stores personnel.

7.6.2 Cost Benefit Analysis

A section of the project submission form covers the expected benefits of the project, including the anticipated financial return. At this stage in the evolution of R&D project selection methods used in the Company (see Chapter 5), FTL was still using "payback period" as the key criterion for selecting projects. The projected savings for the project were based on the expected reduction in labour required to operate the AAC 411 sewing machines when linked to the Jet Sew Loader. From information received from Jet Sew and from discussions with Bassett-Walker, it was assumed that one operator could work three Automatic Loader-AAC 411 machine combinations. This meant that for every three loaders installed, the manning levels could be reduced by three – two direct operators who worked the AAC 411 machines plus one indirect operator who brought work to and away from the machines.

The estimated savings for an initial set-up of three loaders was calculated as being £42,092 per annum, with a capital cost for three loaders of £66,666, giving a straight payback period of 1.58 years. This equates to a saving of £14,031 per year for each loader installed, with the potential to implement up to twelve loaders, which would yield annual savings of £168,368. A detailed breakdown of the calculations used is included in the project submission form in Appendix G (iii).

It should also be noted that when the project was originally proposed and included in the total R&D project list for 1997, the payback period per machine was calculated as being 1.18 years. However, by the time the project submission form was compiled, more reliable data on machine cost and likely man-machine ratios were available and a decision was taken to use the most recent data. The original projected costs were estimates when the portfolio analysis was being carried out and needed to be revised based on the most accurate information available.

7.7 Project Timeline & Gantt Chart

All technology acquisition and R&D projects in the Company require a formal project plan to be drawn up using Microsoft Project. This plan shows not only milestones, but all tasks planned over the entire lifecycle of the project. It must be updated regularly to include any new task or activities that actually happened but which were not planned originally. The output from this application is usually in the form of a Gantt chart showing tasks, start and finish dates, duration, resource names and percentage of the tasks complete. The Gantt chart for this project is shown in Appendix G (iv).

Much of the early work on the project involved liaison with the supplier and modifications of the AAC 411 and Jet Sew Loader to allow the coupling of the machines. The modifications to the equipment were carried out in the U.S. between the 20th October 1997 and 1st May 1998, after which the machine was shipped to FTL Ireland. The project engineer (Mark Baldrick) and head mechanic (Sammy Wilson) visited Jet Sew for one week during April 1998 to review the project with Jet Sew and to see the machine in operation. The researcher accompanied them on this trip to see the machine and also to interview project representatives from the supplier firm in relation to this research.

The machine arrived in Ireland on 18th May 1998 and was put into position in the Automatic Sewing department to await the arrival of the Jet Sew technician to commission the machine and carry out training. The Jet Sew technician was on-site from 3rd June through to 20th June. The machine started running on a single shift operation (8 hours per day) on 8th June 1998, with an operator (Gary O'Donaghue) assigned full-time to the machine from 10th June.

FTL had acquired the machine on the basis that it would be trialled in a production environment for a period of 4 months and this was agreed with Jet Sew at the start of the project. This duration was viewed as allowing sufficient time to get the machine up and running and to determine its performance in terms of the measures and parameters on which the project success would be decided. However, this period covered a three-week shutdown for annual holidays, which actually changed the target date for the end of the trial to

October 1998. Allowing for time to complete data analysis and decision on the success of project, the project close date was to be 18th December 1998.

7.8 Project Performance Measures

FTL Ireland had developed key performance criteria, which must be attained in the use of manufacturing technology in order for the technology to be deemed successful. The measures used tended to be based on traditional manufacturing measures such as output, quality, reliability and cost. The performance data recorded also varied depending upon the process area into which the technology was being deployed. For example, in a project to acquire a new machine for the dyeing or colouring of fabric, the measures used would also include chemical usage and effluent levels produced.

7.8.1 Primary Performance Measures

As this project was one of many sewing automation projects at the time, the primary success measures were well established. These measures had been determined by R&D and manufacturing personnel based on their experience on previous sewing automation projects.

The primary measures used were:

1. Machine Output – as determined by Industrial Engineers using engineered methods and measured rates (of output) based on an operator performance of 100%. The target quantity is normally expressed in dozens or units expected to be produced during an eight-hour shift e.g. 304doz/ shift in this case study.

2. Machine Reliability – the machinery must attain a 95% uptime i.e. machine breakdown must not exceed an average 5% over the trial period.

3. Product Quality – the number of defective or rejected parts being produced (in this case T.Shirt sleeves) by the operation must be 2% or less.

4. Payback – versus original estimated payback of 1.58 years.

The data listed in measures one to three above is captured at the machine and recorded onto a sheet by the relevant personnel. It is then entered into a Microsoft Excel worksheet for calculating percentages and recording the actual measures attained. This information is then summarised on a weekly basis. An example of the weekly reports for production, quality and machine breakdown from this project is shown in Appendix G (v).

At the end of the trial production period, actual results are compared to the established targets and this information is used by the project team to determine whether or not the project has been a success.

7.8.2 Secondary Performance Measures

The project team held the view that some secondary benefits could be achieved through the implementation of this automated sewing technology. The perceived benefits were established as being:

- Ergonomic - through the elimination of the highly repetitive limb motions required when operating the AAC411 machine versus those required for the automatic loader. This in turn would reduce the risk of repetitive strain injury (RSI) normally associated with operating such equipment.

- Tediousness – it was also recognised by the department supervisor and the operator that the use of this Loader would alleviate the boredom experienced when operating the AAC411 machine alone.

7.8.3 Discussion - Comparison of Project Performance Measures with the Measures Checklist

The section compares the checklist of measures used to determine success or failure established from the survey of projects in Chapter 4 with the primary and secondary measures used for this project. In measuring the performance of manufacturing equipment, it must be noted that there are interdependencies between measures. For example, the number of units output from a machine will be impacted by the reliability of the equipment; if the amount of machine downtime increases, the output will normally decrease as will the efficiency, performance and utilisation of the machine.

A comparison of the measures checklist versus those proposed at the start of the project is shown in Table 7.3. As is evident, only four primary and one secondary measure were planned to be used at the start of the project to gauge whether the project was a success or a failure. These were typical of the standard measures used by the Company at the time for most MTA projects and were significantly less in number than the thirty-eight measures found in the original survey (Chapter 4).

	Measures from Survey	Auto Loader Project Measures (at start of project)	
		Primary	**Secondary**
Manufacturing	Production output	✔□	
Performance	Quality	✔□	
Parameters	Downtime/ uptime/ reliability	✔□	
	Amount of maintenance		
	Efficiency/ performance/ utilistion		
	Scrap/ waste		
	Frequency of problems		
	Functionality		
	Throughput		
	Set-up & changeover times		
	Machine Capacity		
Operational	Plant space		
	Ergonomic benefits		✔□
	Training times		
	Deskill operations		
	Flexibility		
	Ease of implementation		
	Plant Capacity		
Management	Management information		
	Management control		
	Data integrity		
Time	Time taken		
	Schedule / start & finish on time		
Economic	Operating costs		
	Cost - capital + other		
	Savings - labour / material		
	Within budget		
	Return on investment /payback	✔□	
	Profitability		
	Patent revenue		
Business	Business objectives strategy		
	Meeting customer needs		
	Additional / new business		
	Customer Returns (RTM's)		
	Marketing		
	Supply chain integration		
	New product derived		
External	Compliance with regulatory bodies		
Total	38		

Table 7.3: Comparison of Measures from Survey with those used in Auto Loader Project.

7.9 Results from Analysis of Project Documentation

The primary measures mentioned previously were recorded over the project lifecycle and the data for each measure tabulated on an excel spreadsheet. This data was then represented graphically.

7.9.1 Production Output

Production Output is the number of units produced by the machine per unit time, normally expressed as units per hour or shift (8 hours). In this case the target output was defined as being able to produce one dozen every

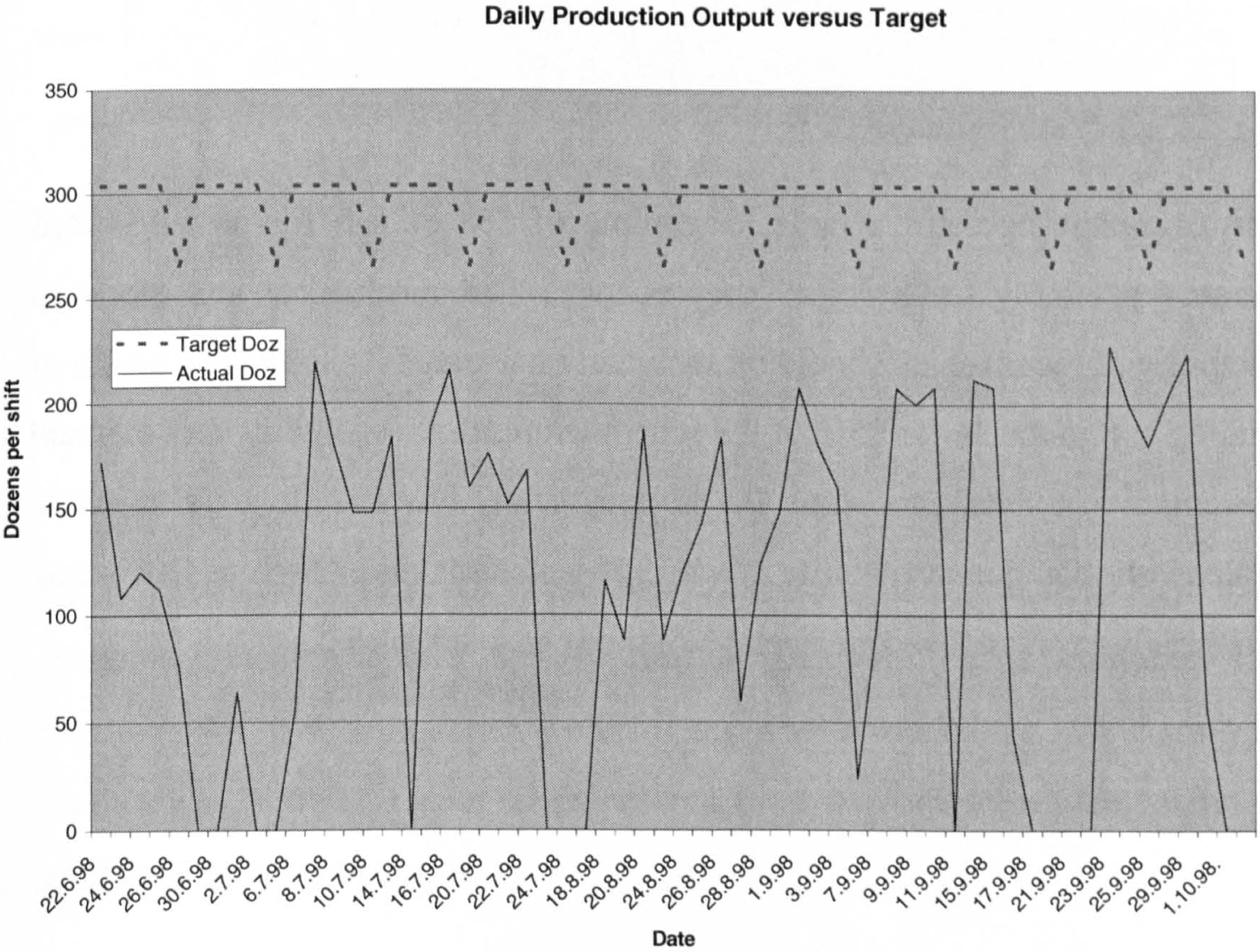

Figure 7.6: daily production output from the machine versus target. The target is lower every 5th day due to fewer hours being worked.

1.58 minutes. Therefore, over a standard shift period of 480 minutes, the machine in theory would be capable of producing 303.8 dozen pairs of sleeves (7,291 units or individual sleeves). Fig 7.6 shows the graph of the actual dozens produced per shift each day against the target dozens from the measured rate of 1.58 minutes per dozen over the trial period of operation. As is evident from the graph, the actual output achieved throughout the trial period was substantially lower than target, and fluctuated significantly from one day to the next. The output attained averaged only 50% of target for the days the machine was scheduled to operate. If all available run days are considered, the average output drops to 38% of target. There is no clear improvement trend on the graph. An example of the daily and weekly production summary sheet from which the above data was extracted can be found in Appendix G (v).

7.9.2 Machine Reliability

The Company operates a target downtime of 5% or less for all automated garment assembly technologies they acquire. The mechanical and electrical reliability of the machine should be such that on average it should be capable of running continuously for 95% of the scheduled runtime (excluding any planned preventative maintenance time or stoppage not due directly to a machine related issue e.g. non availability of work, absenteeism, etc). Machine Downtime is normally expressed as a percentage of the scheduled runtime.

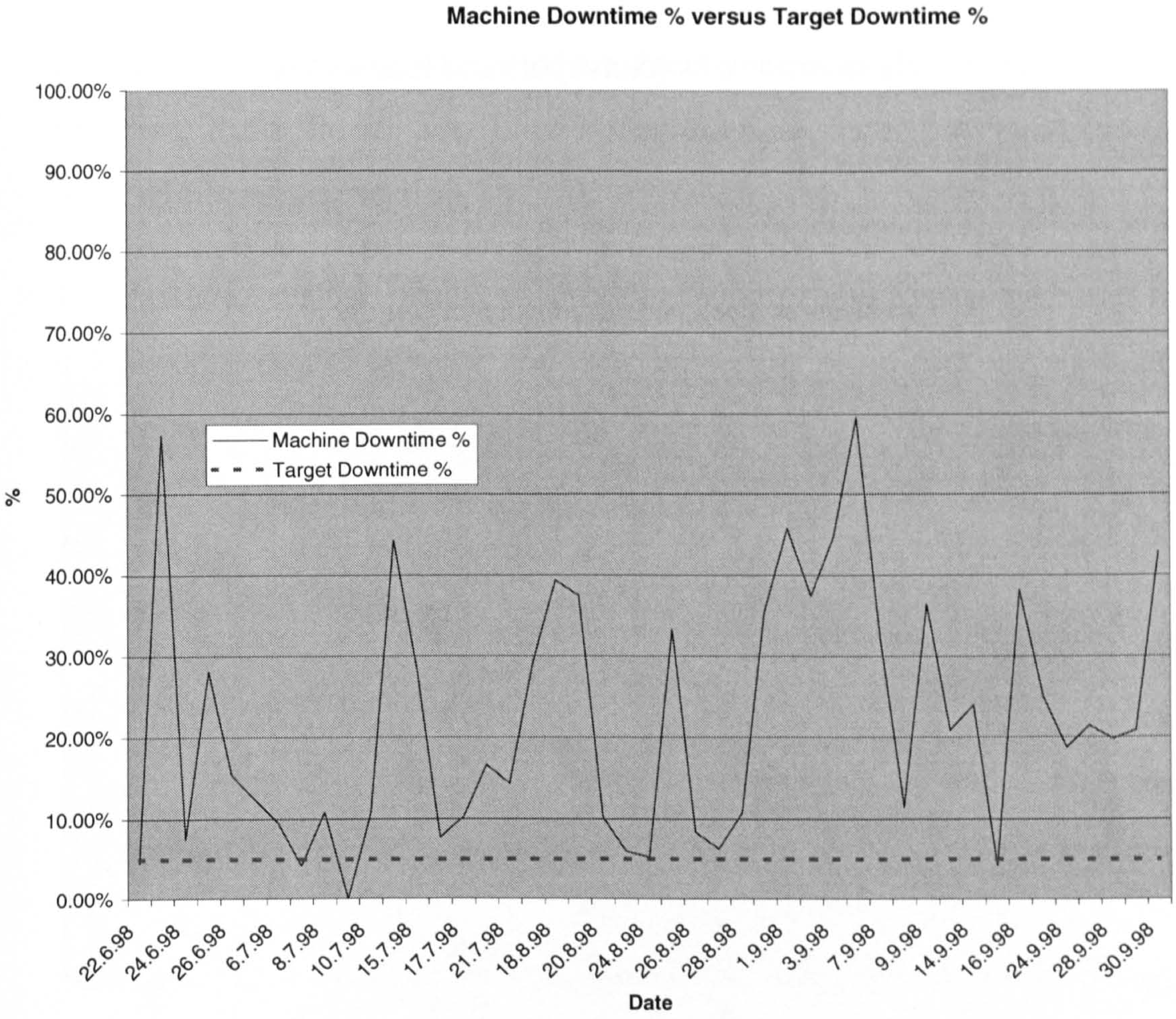

Figure 7.7: Daily machine breakdown level versus target

As is illustrated in Figure 7.7, the mechanical and electrical reliability of the automated loading system fell way short of the target 5% downtime level. In fact, the machine downtime as classified above averaged 22.38% during the trial period. Note that days when the machine was not scheduled to run are excluded from this analysis.

Figure 7.8 shows an analysis of the machine breakdown by cause. 15% of the downtime was caused by the "picker" problems, a fundamental component of the machine that lifts the sleeve from the stack and positions it onto the alignment conveyor for feeding the sewing machine. Other major breakdown causes included problems with belts (conveyor) and machine setting issues.

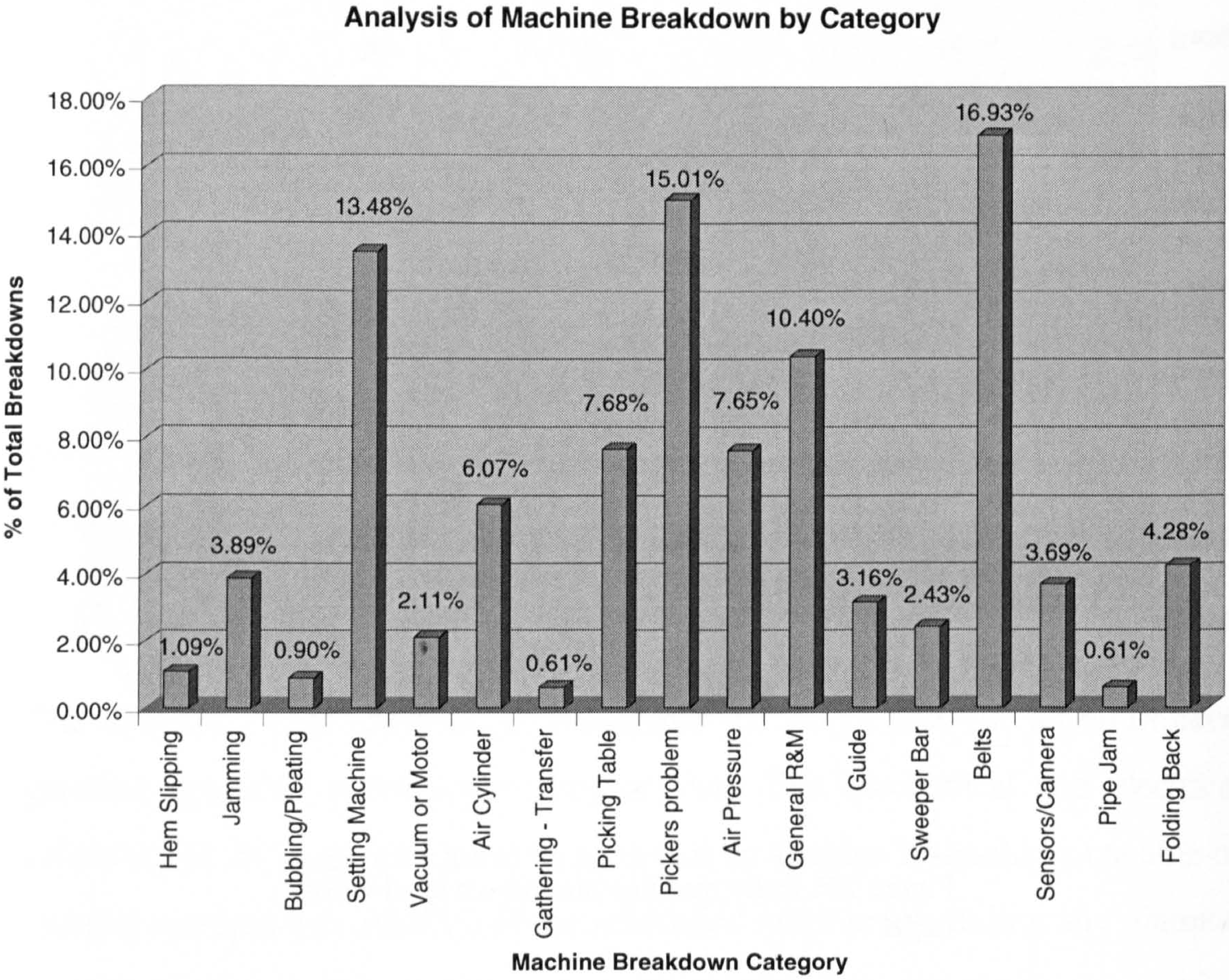

Figure 7.8: Machine breakdown by contributing area of machine.

7.9.3 Quality of Product Output

The Company established a target of 2% or less defective parts being produced in automated garment assembly operations. As this project involved the coupling of two individual machines, it was decided to record quality faults relative to both the automated loader section and the AAC 411 machine using separate recording sheets. The rationale for this was that the quality of product from the AAC 411 could be directly impacted by the presentation of the work from the Jet Sew Loader, for example, incorrect alignment to the AAC 411 hemming section.

The raw data on the quality of product being produced was gathered by an independent quality auditor and was based on an in-process audit of the sleeves being produced. The agreed target sample size for the audit was 50% of all production. An analysis of the percentage of defective sleeves due to the operation of the Loader section is shown in figure 7.9.

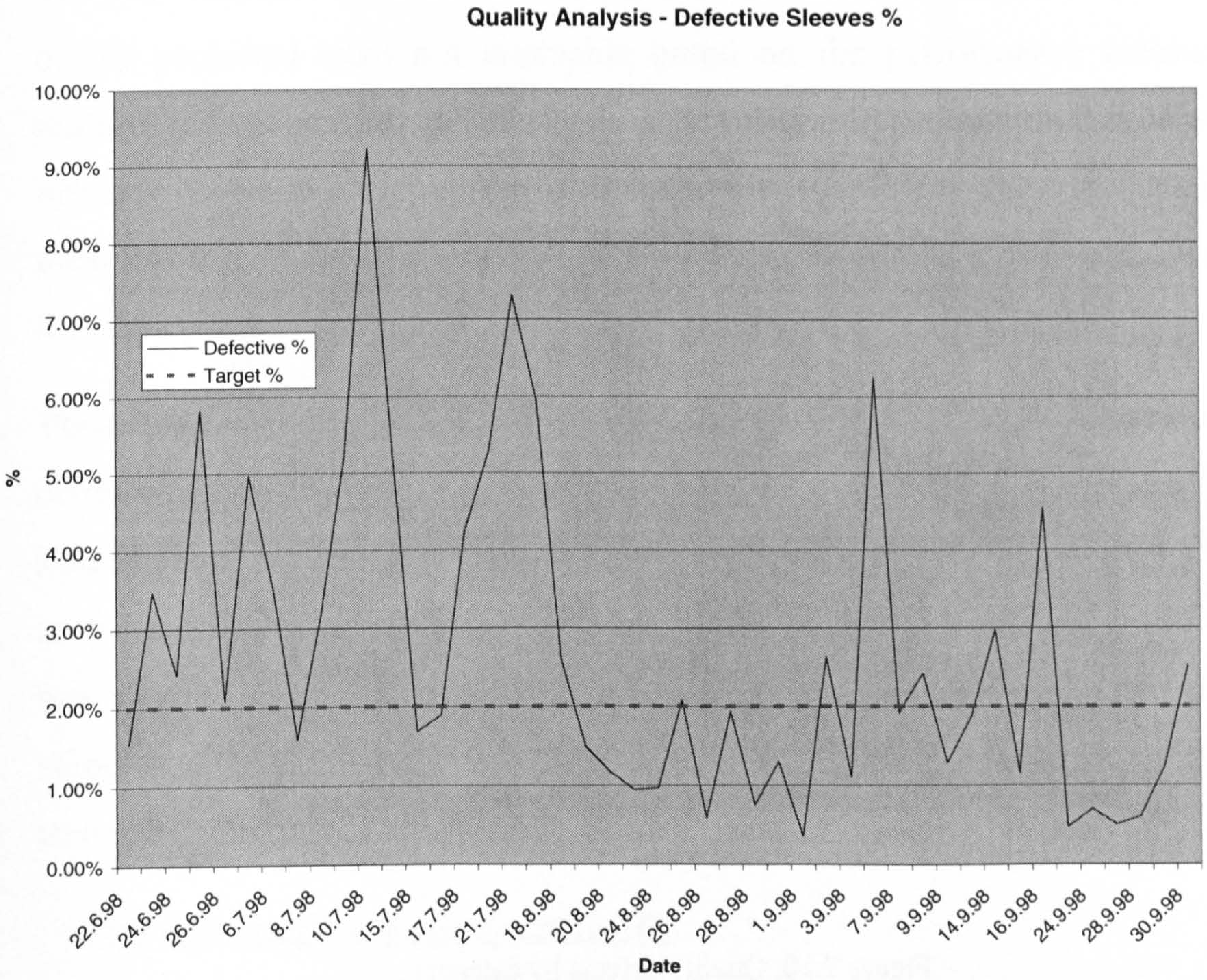

Figure 7.9: Defect Levels against target.

The number of defective sleeves averaged 2.41% for the days audits were carried out during the trial against a target of 2% or less. It can also be seen from the graphical analysis that the trend for the number of defective parts being produced is downwards towards the end of the project. In fact from the 18th August until the end of the trial, the average defect level was 1.38%, which indicates that this measure would likely have been attained if the project had proceeded.

During the trial, 72,720 sleeves were audited and a total of 1,749 defects were detected (2.41%). A percentage breakdown of the 1,749 defects by category is shown in Fig 7.10. As an example of a fault, open hem, is where the sleeve failed to be sewn along part of a seam due to misalignment by the loader.

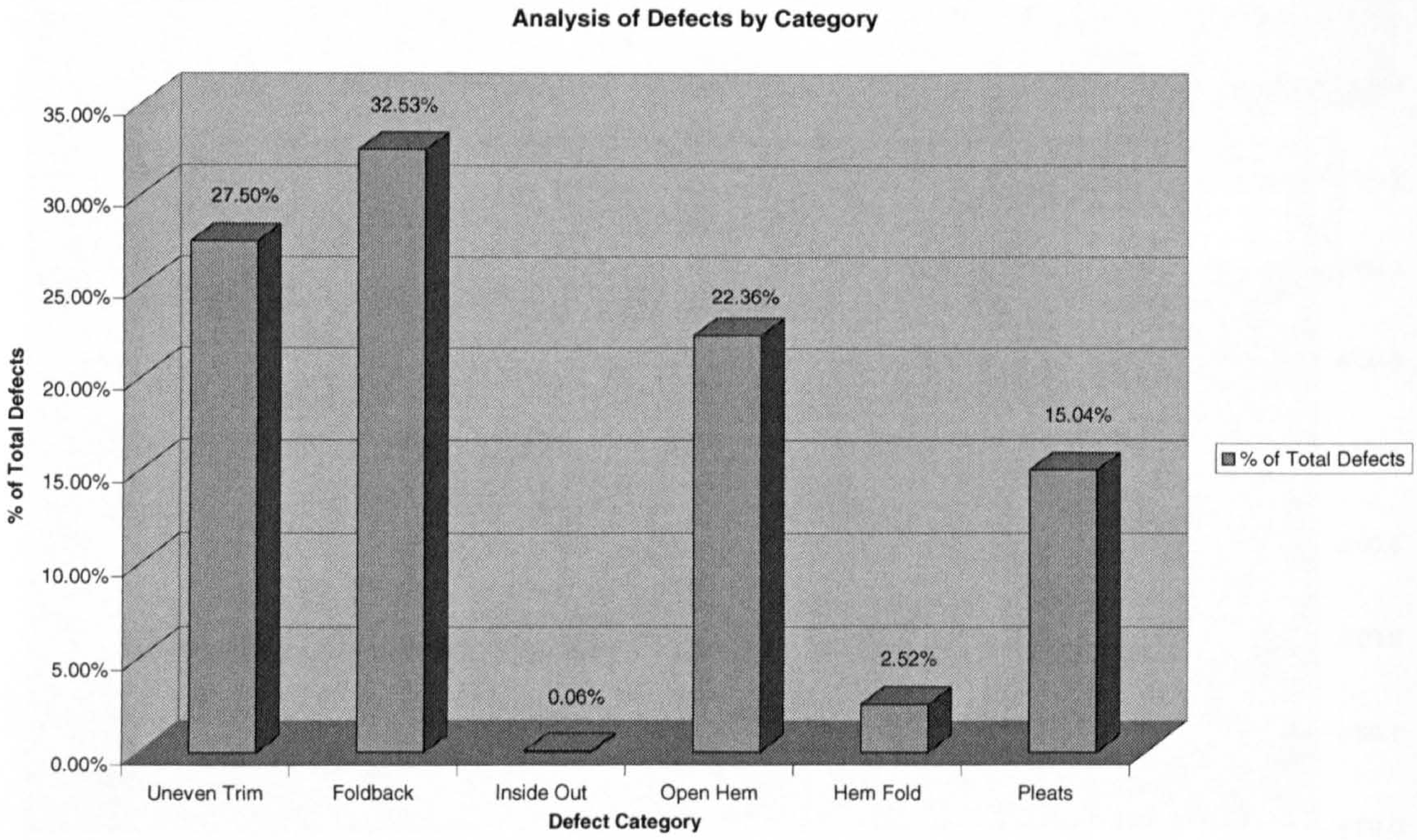

Figure 7.10: Quality defects by category

7.9.4 Conclusions from the Analysis of Project Records

During the trial period of operation, the key performance measures used to assess manufacturing technology were very clearly not achieved. As the machine breakdown was excessive at an average of 22.38% during the trial, against a target of 5%, this in turn impacted directly on the production output capability of the machine resulting in significant under-performance against expectations. The production output per day against target averaged only 50.13% on the days the machine was in operation throughout the entire trial period.

The projected savings and return on investment calculations used at the outset of the projected were not attainable based on the performance measures realised during the trial, specifically those in relation to production output and machine downtime. However, the team was confident that the quality measures required could have been achieved over time, as was the case during the latter part of the trial.

Therefore, on pure machine performance measures alone, the project was deemed to have been unsuccessful. The decision to terminate the project was made by the project team with sign-off by senior manufacturing managers. In so far as this project was a machine trial, it could be argued that the project was successful as the decision not to adopt the technology was taken, thus eliminating the possibility of multiple failure through replication of the technology within manufacturing.

7.9.5 A Strategic Change Event (SCE)

In the second week of September 1998, Fruit of Loom's CEO, Bill Farley, arrived in Ireland accompanied by seven of his U.S. senior management team (on the CEO's $26million corporate jet!). Management based in Ireland were advised of the visit, but were not aware of what items were going to be on the agenda. As it turned out, he announced a major strategic change for the European business, which was to have a significant impact on the manufacturing operations in Ireland, and on the MTA project portfolio.

At the first meeting of the week, the CEO announced that all sewing operations based in Ireland would have to be relocated to Morocco as quickly as possible. He went on to say that three sewing facilities would close by December 1998, and that the remaining three plants needed to close by the end of 1999. This would ultimately result in the loss of approximately 1,500 jobs. The Executive Vice President of Operations, Edgar Turner, stated that alongside this change in strategy a new method of manufacturing would be introduced, founded on team-based manufacturing processes and Kaizen[1] manufacturing principles, both in Morocco and also in Ireland (for as long as the sewing plants were still operational).

This change in strategy was only shared with the senior management team in Ireland, and not with middle management. Thus, the project team members were unaware of the new strategy and the impact it would have on the Auto Loader project, so the project was allowed to run its normal course. Even if the machine had attained all of the Company's performance targets, the project would not have gone on to the replication phase, due to this strategic change.

This strategic change event signalled the end for this project. It also meant that any other planned automated sewing MTA would be cancelled.

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[1] Kaizen is a manufacturing philosophy developed by Masaaki Imai in Japan in the 1980's. It is a culture of continuous improvement focusing on eliminating waste in all systems and processes of an organisation (www.kaizen-institute.com).

7.10. Results from Interviews with Participants

The interview method was described in chapter three, section 3.7. As part of the research process of taking a more in-depth look at a single MTA project, it was determined that it would be appropriate to use qualitative research methods alongside the quantitative ones used earlier in reviewing the project documentation. In-depth interviewing is regarded as the most fundamental of all qualitative methods (Easterby-Smith, Thorpe and Lowe, 1995). The purpose of these interviews was to further explore the findings of the earlier research work on factors and measures at a single project level.

Interviews were conducted with the project team at the outset of the project and also when the project had been completed. The researcher also interviewed two representatives from the Supplier Company, Jet Sew, at their headquarters in the U.S. before the machine was shipped to FTL Ireland. Both the President of Jet Sew and the Auto Loader Programme Manager were interviewed at length in April 1998 in relation to this project. The internal FTL project team member respondents were interviewed in July 1998 just ahead of the full trial commencing. The machine was on site at this stage and they had had the opportunity to see it working before the interviews were conducted. Some of the team members were again interviewed after the project had concluded. Unfortunately, by the time the second series of interviews were undertaken, many of the original team members had left the Company due to strategic changes resulting in widespread redundancies. All interviews were recorded to facilitate further analysis.

Examples of full interview transcriptions with Jet Sew's Programme Manager and Company President are given in Appendix G (ii).

7.10.1 Interviewees and Positions

Table 7.4 lists the people interviewed and their respective positions, which in turn impacts on the roles they had during the project. The participants were all regarded as being key players and stakeholders in the project and were selected for interview on that basis.

Interview No: / Name	Position
Before Project	
1. Ernst Schramayr	President, Jet Sew
2. Robert Beasock	Programme Manager, Jet Sew
3. Joe Mullan	General Manager, Sewing Operations (FTL)
4. Michael Donaghey	Production Supervisor, Automatics Dept (FTL)
5. Owen Doherty	Mechanic, Automatics Dept (FTL)
6. Sammy Wilson	Head Automation Engineer (FTL
7. Mark Baldrick	Project Engineer, R&D Dept (FTL)
8. Gary O' Donahue	Machine Operator (FTL)
After Project	
9. Joe Mullan	Senior VP, Manufacturing (FTL)
10. Catriona Kelly	R& D Manager (FTL)
11. Mark Baldrick	Project Engineer, R&D Dept (FTL)

Table 7.4: Names and positions of team members interviewed.

7.10.2 Semi-Structured interviews with the FTL Team at Project Start

All interviewees were briefed in advance on the format and purpose of the interviews. An example of the interview sheet used is given Appendix G (vi). However, as is the case with semi-structured interviews, the actual transcriptions of the interviews illustrate that many other aspects of the projects were explored depending upon the how the interviews proceeded. Examples of full interview transcriptions are given in Appendices G (ii) and G (vii).

In the case of the Auto Loader project, all interviews were transcribed onto Word documents to facilitate further analysis using the qualitative data analysis methods described in Chapter 3. This data reduction process yielded condensed data in the form of clusters of vignettes of text, which was then compared against the success factors and measures checklists. The interviews were reviewed a number of times and key terms and phrases highlighted in the text. Labels were then attached to the clusters, some referring to specific success factors and measures mentioned in the interviews, and some labels referring to more emergent project issues. An example of an interview transcription, which illustrates this analytical approach is shown in Appendix G (vii).

The following section shows some of the clusters for given labels or groupings extracted from different interview transcriptions. Key phrases obtained during the interviews are also shown.

7.10.3 Examples of Clusters

Interviews 9 to 11 are after project closure.

Cluster: Success Factors
Factor: Team Composition

Interview No: 7

"My role is project manager of the project...to co-ordinate all the tasks and functions within that, making sure I have all the relevant people within the different areas that are actually involved in the different projects..."

"A lot of work was actually done then as there was a lot of ringing around, getting the right personnel..."

"That's what it is...the teams I've picked...always make sure you pick the best team....the people with the most experience, like Sammy...he would have the most experience in automation."

Interview No: 3

"The right resource base will have been structured, the right assessments and the environment for those will have been created so that we can pay due diligence to everything from quality, output, compatibility with the operators, etc. etc. .."

Interview No: 4

"Unfortunately I wouldn't have liked the guy that was here to stay.... I would have liked somebody who was more familiar with the machinery".

"he was not familiar enough with the machine.... but I would say that he wouldn't be the kind of person I would send out to fix a machine or put in machines".

Cluster: Success Factors
Factor: Strategy/Strategic

Interview No: 10

"At the time, it was probably the strategy of the Company to invest in automation, but this changed almost overnight".

"I don't think so...as I said our strategy at the time was to invest in automated sewing technology and this was what we were doing."

"I probably know what is happening for maximum the next two years, but I'm sure Joe [Mullan] knows the longer term picture."

Interview No: 3

"I think it will certainly condition my outlook on the next five, seven years in that I can successfully defend a certain type of structured sewing base in Western Europe."

Interview No: 1

"Because they were going offshore. It seems that there was a real conflict between upper management strategy – their long-range strategy – and the people in manufacturing. They were never really told. Manufacturing seemed to have their own agenda which was keep production domestic [in U.S.A.] while senior management had already a strategy for going off-shore, probably one-hundred percent."

"Senior management never told them it was their strategy to shut down here and go offshore. They never told them, or if they told them they wouldn't believe it."

Interview No: 9

"My recollection is that our whole strategy changed away from automation within an Irish sewing environment."

"Well the U.S. basically landed in a plane one day and told us they had changed to the Kaizen method of manufacturing as two of their senior guys had used it before ...so I suppose it was sort of imposed on us....but it was done so quickly, that was the problem."

"I think we're a lot clearer now about what our future manufacturing strategy will be, probably more so than ever. We'll invest capital in our textile operations and not much in sewing. We'll try and catch up with the latest technology in Spinning where we are now about ten years behind, but at least money is being made available again…and as we emerge from Chapter 11, this forms part of our restructuring plans to the Courts in the U.S."

Interview No: 11

"We had a final project review where we decided that it wasn't working. Also, the States had taken a decision to implement modular (Kaizen) manufacturing in Morocco and this put a damper on the project. Honestly, even it had been a success, we would probably have stopped it anyway because of the decision by the States [FTL] to go this way in Morocco".

These statements are short extracts from the interviews and illustrate how clusters can be formed and labels attached.

7.10.4 Matrix Display of Success Factors present in Case Study with those in Original List

The next step in data reduction and display was to develop a matrix contrasting the factors derived from the Auto Loader case study clustering and labeling process with those previously listed in Chapter 4.0. Therefore, each of the labels developed during the analytical progression was displayed in the matrix in Table 7.5.

	Factors			Interview Number												
		1	2	3	4	5	6	7	8		9	10	11	Total	Avg	f
	Code	ES	RB	JM	MD	OD	SW	MB	GOD		JM	CK	MB			
Organisational	Need	1	1													2
	Clearly defined objectives	1														1
	Objectives understood	1														1
	Strategic aspect	1	1	1							1	1	1			6
	Vision										1					1
	Org/Dept structure										1					1
	Internal competition	1														1
	Environment / Change	1	1					1			1	1				5
	Communication	1			1	1										3
Analytical	Proper analysis										1					1
	Sufficient evaluation		1					1								2
	Competitor analysis							1								1
	Statistical analysis															0
	Background analysis															0
	Identify constraints		1								1					2
	Documentation		1		1											2
	Format of information				1											1
	Customer needs / wants - survey	1														1
Technical	Design	1	1		1	1	1	1	1			1	1			9
	Specification					1	1									2
	Define functionality		1													1
	Fit for purpose / application											1	1			2
	Equipment age															0
	Reliability		1				1		1		1					4
	Sufficient Development	1			1		1									3
	Computer controlled															0
	Ease of re-set				1	1	1		1			1	1			6
	Ease of maintenance		1			1	1									3
	Set-up time				1		1		1			1	1			5
	Understand technologies / science	1			1						1		1			4
	Know technologies available / selection															0
	Upgradable	1														1
	Complexity					1	1	1								3
Management	System/ Methodology			1	1								1			3
	Planning							1								1
	Top management support	1	1								1					3
	Team composition	1		1	1	1	1	1								6
	Team cohesion															0
	Team balance															0
	Implementors															0
	Sufficient time				1	1	1	1				1				5
	On time															0
	Knowledge of procedures															0
	Hard work / long hours/ Workload							1					1			2
	Skill of project manager															0
	Know people involved	1						1								2
	Structured project management			1	1											2
	Cross functional teams / integrated															0
	Financial support	1	1													2
	Control			1							1					2
	Review		1													1
	Project owner / champion	1	1													2
	Human resources available	1		1				1			1					4
Human	Level of knowledge	1		1									1			3
	Experience							1								1

	Drive / motivation / enthusiasm							1								1
	Level of conviction / commitment	1						1					1			3
	Perceptions															0
	Negotiation skills															0
Operational	On-going production not affected							1								1
	Trial run / pilot	1	1	1												3
	Preventative Maintenance Programme															0
	Slow build-up / ramp-up															0
Supplier Issues	Supplier selection															0
	Narrow down															0
	Confidence in Suppliers				1								1			2
	Supplier relationships		1									1	1			3
	Support	1			1	1			1							4
	Frequency of contact															0
	Co-ordination of Suppliers							1								1
Legal	Patenting															0
	Patent Attorney skills															0
External	Sales Levels	1	1													2
Environment	Misc Events															0
	State of Industry	1														1
																134
	75	24	17	8	14	9	10	16	5		11	8	12	134	12	

Table 7.5: Comparison of Factors found in Single Case with those derived from previous candidate survey.

Interview numbers 1 to 8 were undertaken at the outset of the project, whereas interviews 9 to 11 occurred after project completion. Also, interviewees 3 & 9 were with the same person, before and after the project, as were interviews 7 and 11.

The total number of factors present was 53 out of a possible 75 (71%), indicating a relatively high level of occurrence of factors in this single case study. In total, 134 factors (some the same) were extracted from the interview data. The average number of factors per interview was 12.2, higher than the 8.7 average factors per interview in the original survey (Chapter four). This is not surprising, because there were several interviewees for this one project. There was a strong clustering of factors within the "technical" category, with 43 of the 134 total (32%) assigned to this category alone. Examples of the occurrence of factors within this technical category include "design" which was stated in 9 of 11 interviews and "set-up time" which occurred in 5 of 11 interviews.

7.10.5. Matrix Display of Success Measures present in Case Study with those in Original List

A Matrix display was developed to compare the measures derived from the Auto loader case study with those determined from previous research work as discussed in chapter 4. This matrix is shown in Table 7.6.

	Measures			**Interview Number**										FTL	
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*			*f*
	Code	ES	RB	JM	MD	OD	SW	MB	GOD	JM	CK	MB			
Manufacturing	Production output	1		1	1	1	1	1	1		1	1		X	9
Performance	Quality			1	1	1	1	1	1			1		X	7
Parameters	Downtime /uptime/reliability				1	1	1	1	1	1		1		X	7
	Amount of maintenance						1			1	1				3
	Efficiency /performance/utilistion														0
	Scrap/waste					1									1
	Frequency of problems										1				1
	Functionality						1				1				2
	Throughput		1												1
	Set-up/changeover times						1				1	1			3
	Machine Capacity														0
Operational	Plant space		1							1	1				3
	Ergonomic benefits				1	1	1		1					X	4
	Training times														0
	Deskill operations			1				1							2
	Flexibility			1											1
	Ease of implementation									1					1
	Capability									1					1
Management	Management information			1											1
	Management control														0
	Data integrity														0
Time	Time taken														0
	Schedule - start & finish on time														0
Economic	Operating costs	1	1					1							3
	Cost – capital + other	1	1					1							3

	Savings - labour / material		1	1		1	1	1	1	1					7
	Within budget														0
	Return on investment /payback	1	1	1							1			X	4
	Profitability														0
	Patent revenue														0
Business	Business objectives / strategy	1		1				1		1	1	1			6
	Meeting customer needs	1	1	1											3
	Additional / new business	1													1
	Customer Returns (RTM's)														0
	Marketing														0
	Supply chain integration														0
	New product derived														0
External	Compliance with regulatory bodies														0
															74
		7	7	9	4	6	8	8	5	7	8	5	Tot	Avg	
	38												74	6.7	

Table 7.6: Comparison of Measures found in Single Case with those derived from previous surveys. Note. The column 'FTL' and an 'X' entry against a factor indicates a standard FTL MTA project measure.

The total number of measures present was 23 out of 38 (61%), again indicating a relatively high level of occurrence of measures. The average number of measures per interview was 6.7 compared to 5.8 in the multi-case survey. In total, 74 measures were stated in the 11 interviews, including some measures stated more than once. The category of "Manufacturing Performance Parameters" yielded a particularly strong clustering and accounted for 46% of all stated measures across the 11 interviews. Examples of the occurrence of measures within this category include "production output" which was stated in 9 of 11 interviews, whilst both "quality" and "downtime" occurred in 7 of 11 interviews.

7.11 Case Study Findings and Conclusions

The following sections report on the findings from this study of a single case and review these findings against the earlier work in this research.

7.11.1 Support for Factors

This case study gave strong support for the Factors list. 53 of the success factors that had been identified in the original interviews (Chapter 4) were identified in the interviews on this single case, and 22 were not. Only one new factor arose in this single case, which was "training of personnel" in the use of the machine.

The interviews used to establish the original list of factors (Chapter 4) took place some time after the events of the projects. In the present case, an enormous level of detail was available in the daily and weekly reports, and a team of people was interviewed close to the events. The fact that such similar lists of factors emerged in the two studies gives strong support to the validity of the factors list which emerged from the original interviews.

The high number of factors occurring in this single case was a surprise. This indicates that this case at least was surprisingly complex. Whether all cases are like this would be a matter for further investigation.

A few factors were mentioned many more times than others. These "strong factors" may be more important than others, at least in the case studied. Strong factors mentioned in the early interviews in this case were Supplier Support and Team related issues. Strong factors mentioned after the project were Design and Strategy. This supports the earlier research work of Balachandra and Friar (1997) in that the appearance or nonappearance of critical factors is context based, and that different variables will be critical in different projects and indeed at different times in the project. The findings lend support to the completeness of the original list of factors determined in the external survey, as only one new factor was found in this detailed single case.

7.11.2 Support for Measures

23 of the 38 success measures were present in this case, with no new measures being discovered. Another important issue is that the measures' list is much more comprehensive than the factory's far smaller number of standard manufacturing performance measures (those used to decide project outcome). Again this gives strong support for both the validity and completeness of the list of measures. The first three measures in table 7.6 are major issues in any Company and clearly were very much in the consciousness of the interviewees.

7.11.3 Support for Portfolio Approach

The Portfolio approach (Chapter 6), which is based on the assumption that you cannot predict success and must therefore run a collection of projects in a staged manner, balancing risk and potential reward, is supported by the events of this single case. The FTL team and the machine supplier seemed convinced in the early stages that it was going to work. At the outset of the trial, there was a high degree of confidence, based on previous successes with the supplier and a good relationship.

7.11.4 Support for the Replication Concept

Through the process of undertaking a comprehensive and thorough trial before committing to replication, large-scale investment in technology that would have failed to meet expectations was avoided. It is important to note that "bulk purchase", whereby the Company would have purchased several of these machines at once, had been the previous method of acquisition employed by the Company prior to the 1996 round of project selection. The unpredictability of outcome justifies a portfolio approach ahead of "Replication".

7.11.5 Emergent Concepts

Three new concepts for consideration emerged from the single case study:

1. **Multiple causes of failure.** The project would have failed on any one of a number of measures. Most of these were technical measures. If the project had not failed for these reasons, it would have failed subsequently for strategic reasons. Not only would it have failed because a strategic decision was made to move sewing operations to a low-cost labour country, but it would have also failed because a new method of team based manufacturing assembly was being introduced, which would have resulted in the demise of automated sewing technology. Success or failure can be determined using one or a combination of measures and can be caused by one or a combination of factors. There can be overkill – this project would have been killed several times over.

2. **Uncertainty of result.** All of the project players were confident at the start. Nevertheless, the evidence was there of danger areas, but among the large number of considerations and the absence of a checklist of factors, significant indicators can be missed, as happened in this case. An unexpected event that seemed important at the time was that the supplier's technical expert on this machine left the company and so was not available to help with its commissioning in FTL Ireland. The best judgement of those present was that his presence would have been very useful, but would not have changed the outcome of the technical failure. However, we have no way of knowing whether this is so or not and there is the possibility that the project failed because of a circumstance which occurred rather than a factor

built in from the start. The significance of this uncertainty seems to be that when circumstances have changed like this, the project's prospects have changed and re-evaluation is appropriate. This supports the staged approach to projects, i.e. pilot phase prior to replication.

3. **Corporate Environment Factors.** Several mentions of the strategic issue of moving production to low-cost countries were made in the original interviews. People were aware that FTL in the U.S. had been moving production to Central America and their own manufacturing Company in Ireland was moving sewing production to Morocco. Even so, no alarm was expressed that this might be a threat to this project. Among more senior interviewees there was probably recognition that there was a debate in the Company between the high-tech approach and the low labour-cost approach, but not only was the outcome unclear, the participants probably could not influence the debate. The automation strategy in the Irish plant had existed for four or five years, with significant investment behind it. When it changed, it was literally overnight and a complete surprise. On the basis of this one case study, strategy can change overnight.

7.12 Discussion

The research findings supported much of the earlier research work on success factors and measures, and lent support for the concept of portfolio management applied to MTA. It also yielded some important emergent concepts and considerations when undertaking MTA.

The original project risks, as shown on the risk versus reward bubble diagram, were high, with only a 30% to 40% chance of success being stated. The risks were considered as high because the machine had only been deployed in one other manufacturing company, in the U.S. However, no assessment of strategic risk was foreseen nor was this discussed at the project selection phase, as EMB and Strategic Importance (SI) were not developed and tested until 1998, and this project originated from the 1997 project selection round. Even if these considerations had been developed, it is likely that the project would have scored relatively high on strategic importance as it was the defined strategy at the time to invest in automated sewing machines.

By the time the project started, the machine had undergone a technical assessment by FTL engineers in the U.S. and in Ireland. The project team had seen the machine in operation on the factory floor before the first interviews were conducted and confidence amongst the team was high, with a common view being that the machine would be made to work and the project would be successful. For example, the Project Engineer (Mark Baldrick) stated in his first interview after viewing the machine in operation on the factory floor that its chances of being successful were in his view around 90%.

Why could the strategic change not have been foreseen? In the interviews with the supplier representatives, there were clear indications that the manufacturing strategy in FTL's U.S. sewing operations had changed with the move of their sewing operations to Central America. They had cancelled their orders with Jet Sew for Auto Loader machines. Was it not likely that the same would eventually happen in Ireland? The answer reflects several issues. Firstly, in Ireland the automation strategy had existed for a number of years and had significant backing, both financially and verbally, from the then Directors in Ireland, so there was no reason for the R&D Manager or any of the project team members to suspect it would suddenly change. After all, strategy has to do with medium to long-term business objectives. Secondly, strategy is not normally the responsibility of middle management, so why should they be concerned about it? Even if they were, it is unlikely that they could actually do anything about it anyway, and thus it is perhaps correct that they exclude it from consideration. In fact, during the first interviews some respondents stated that the project was "strategically important". Thirdly, it is unlikely that the relocation of sewing operations from Ireland to Morocco, with the loss of a significant number of jobs in Ireland was in the best "political" interest of the Irish senior management team.

In the end, although this case validated much of the earlier research work, it also vividly illustrates the nature of strategic change and the significant impact these events can have on MTA management (Figure 7.11). The issue of strategic change events in relation to MTA forms the basis of the next chapter.

Figure 7.11: The redundant AAC411 automated sewing machines stored in a corner of a warehouse, awaiting disposal. These machines cost $100, 000 dollars each and were less than three years old. FTL Ireland had purchased 12.

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Chapter 8

Strategic Change Events

8.0 Introduction

The research was conducted on a part-time basis over almost seven years and many significant changes in strategy were observed within the Company during this time. It became apparent from the single case study in chapter seven that changes in strategy can have a major impact on Manufacturing Technology Acquisition activity. The view could have been taken that the strategic change events imposed on the factory could have spoiled the study of implementation of projects selected by the portfolio process and spoiled the single machine case study by the scrapping of its whole class of project. Instead, it was decided that these "Strategic Change Events" (SCE's)[1] that occurred within Fruit of the Loom were a real research consideration in the context of MTA, and ought to be examined as part of the scope of the research work.

This chapter investigates the wider strategic background against which the sudden cancellation of many MTA projects in Ireland was only a minor event. The chapter includes:

- A retrospective examination of strategic events in the U.S. Company
- A retrospective examination of strategic events in the European Division
- The impact of these events on the MTA process in Ireland

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[1] SCE is the acronym developed by the student.

- A discussion of the tools and techniques developed in the research in the light of these strategic considerations.

8.1 FTL Corporate Strategy

During the period of the research from 1995 to 2002, strategic changes in the business occurred relatively often. These changes often coincided with changes in senior management. The following sections describe events occurring within the Company from 1994 through to 2002, focusing firstly on corporate strategy, which concerned mainly the U.S. operations.

FTL's general business strategy has traditionally been that of a "high-volume, low-cost producer" and thus it competes in the marketplace primarily on price. However, the brand itself is well known, particularly in the U.S., and this too is utilised to drive volume through various sales and marketing initiatives. The Company was generally regarded as a manufacturing-oriented company in the early nineties.

The strategy for the recently acquired Irish subsidiary up to 1994, leading to the start of this research in 1995, had been to invest heavily in high technology production machinery. This continued through the three budget cycles recorded in chapter six. There was then a dramatic change of strategy, which affected the MTA activities. In this section, 8.1, strategic events in the Parent Company are recorded. In the following section, 8.2, strategic events in Ireland/Europe are recorded.

8.1.1 Global Company Strategy in 1994

In 1994, the Company was pursuing an aggressive growth strategy, based mainly on the acquisition of additional businesses believed to be complimentary to Fruit of the Loom's core business. The companies acquired by FTL included:

(1.) Salem U.S.A., a sportswear manufacturing company, for $157.6 million in November 1993

(2.) Artex, a fabric manufacturing company, for $45 million in January 1994

(3.) Gitano Inc, a jeanswear manufacturing company, for $91.4 million in April 1994

(4.) Pro Player, a sportswear licensing company, for $55.7 million in August 1994

These acquisitions, which totalled $349.7 million, were financed through borrowings under the Company's $800 million revolving line of credit, and increased the Company's overall debt level. However, these acquisitions were also primarily responsible for increasing the Net Sales by 22%, from $1,884 million in 1993 to $2,298 million in 1994. Net Earnings for 1994 were $60.3 million compared to $212.8 million in 1993. The decrease in earnings was attributed primarily to administrative expenses and goodwill amortization from the four newly acquired companies.

8.1.2 Global Company Strategy in 1995

In the Chairman's letter to shareholders contained in the 1995 annual report, the Company strategy was stated as consisting of four basic elements[2]:

1) continue to make strategic investments in the business to support its strong brand portfolio, improve customer satisfaction, enhance its world-class manufacturing capability and drive revenue growth

2) improve corporate profitability by lowering costs and expenses throughout the corporation

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[2] Fruit of the Loom Annual Report, 1995

3) reduce the capital intensity of the business and increase working capital turnover, by consolidating manufacturing facilities and reducing inventories.

4) improve cash flow

Sales for 1995 were $2,403.1 million, up 4.6% from 1994, with a net loss of $232.5 million compared to net earnings of $60.3 million in 1994. Some of the main reasons cited for the loss in earnings were the costs associated with closing certain manufacturing facilities in the U.S., where the Company recorded charges of £373 million related to impairment writedowns of goodwill and inventory obsolescence.

Other key business goals or operational activities intended to underpin this strategy included the following:

- In 1995, the Company closed 13 manufacturing facilities in the U.S., mainly sewing plants, with the loss of over 6,000 jobs. This was the start of a major relocation of labour-intensive sewing operations from the U.S. to Mexico and Central America. At the beginning of 1995, 88% of all sewing operations were based in the U.S. However, by the end of 1995, 30% of all sewing jobs had been moved to low-cost locations, with plans to continue with this strategy.

- Capital expenditure was reduced by 40% to $75 million.

- The consolidation of 22 small distribution facilities in the U.S., into 2 larger automated warehouses of 2 million square feet each, took place.

8.1.3 Global Company Strategy in 1996

Note: It may be felt by those not involved that the changes of policies and personnel are as tedious as the politics of imperial Rome. Tables 8.2 and 8.3 summarise the events.

1996 saw a major change in the Company's strategy, as was stated by the Chairman and the Chief Operating Officer in their letter to shareholders in the 1996 annual report (Fruit of the Loom Annual Report, 1996):

> "*Our metamorphosis from a basic manufacturing-oriented business to a savvy marketing-driven Company forced us to dramatically change the way we manage our business. Our friends in the investment community questioned our ability to execute such a massive change in corporate philosophy. And rightly so. It was an ambitious undertaking. We added several key executives during 1996 – an immediate indication of the extent and seriousness of our change in philosophy.*"

This represented a fundamental change in business strategy, whereby the Company wanted to move from a low-cost sales base to a high-price sales strategy through leveraging the brand.

The President and COO, John Holland, left the Company. He had been with the Company for 25 years and had been instrumental in growing turnover from $180 million to over $2 billion during his tenure of over a decade as President and COO. Some of the other executives changes referred to included the appointment of a new Chief Operating Officer (COO), Richard Lappin, and a new Chief Financial Officer (CFO), Larry Switzer. Also, the Chairman of the Board, Bill Farley, began to take a more active role in the running of the business and was appointed to the position of Chief Executive Officer (CEO) as well as Chairman.

Aside from these changes at the highest level in the corporation, there were many other executive level changes including Chief Information Officer, Senior Vice President Sales, Senior Vice President Manufacturing and, Senior Vice President, Legal.

Examples of operational activities following on from this strategic change included:

- Relocation of sewing jobs offshore (Mexico, Honduras and El Salvador) had increased to 58% by year-end. A future target of 80% of sewing operations to be offshore by 1998 was stated at this time.
- Advertising and promotion expenditure increased by 15% to $103 million to support the change to a marketing-led strategy.
- Capital expenditure reduction from $75 million to $44.5 million.

Net Sales increased to $2,447.4 million and the Company returned to profitability, reporting net earnings of $146.6 million (Fruit of the Loom Annual Report, 1996).

8.1.4 Global Company Strategy in 1997

Net Sales declined to $1,931.2 million a with Net Earnings loss of $487.6 million. As part of the restructuring of manufacturing and the continuation of the policy of moving sewing operations offshore, special charges of $442 million were incurred in the fourth quarter of the year alone.

The key elements of the Company's strategy in 1997 were stated as being:

- Continue to move sewing operations offshore to reduce costs and compete with growing import competition that was resulting from the General Agreement on Tariffs and Trade (GATT, 1994)
- Invest $117 million in Advertising and Promotion programmes
- Further invest in its Information Technology infrastructure in support of a "Vendor Managed Inventory" programme to improve customer services

Capital expenditure for the year was $55 million.

8.1.5 Global Company Strategy in 1998

Net Sales were $1,984.8 million generating Net earnings of $135.9 million. The elements of the business strategy as stated in the 1998 Annual Report included:

- Low Cost Manufacturing, whereby the strategy was to use its automated textile manufacturing facilities in the U.S. coupled with low cost offshore operations for labour-intensive sewing activities. At the end of 1998, 95% of sewing operations were located in Mexico, the Caribbean and Central America. To achieve this, a further 9 U.S. sewing plants were closed with the loss of over 7,000 jobs during 1998.

- Utilising contract manufacturers to assemble some of the products offshore in order to balance internal capacity constraints, to manufacture low-volume speciality products and to bridge capacity deficit during the transition to offshore facilities.

- Developing product line extensions and new products to increase overall demand and increase revenues.

- Expanding marketing programs to increase emphasis on product quality and brand awareness (examples included sponsoring the Super Bowl and U.S. football teams). These programs were intended to further establish FTL as a marketing-oriented Company.

- Enhancing Information Systems by implementing Internet based order entry system for vendors.

- Fruit of the Loom, Ltd was set up in the Cayman Islands and became the holding company for FTL, Inc. This Company was set up to avail of tax benefits from income generated outside of the U.S.

Capital expenditure for the year decreased to $42 million.

1998 saw yet more changes in the executive line-up of the organisation. Out went the COO, Richard Lappin, in February 1998, this position being taken up by Bill Farley, who by this stage was Chairman of the Board as well as CEO and now COO. Out too went the CFO, Larry Switzer to be replaced by Bill Newton as "Acting" CFO. Other changes at an executive level included the exit of the heads of sales and marketing, manufacturing and legal functions. In essence, the whole executive team was changed yet again. Their replacements were recruited from outside of the organisation and included:

- Edgar Turner, Executive Vice President – Operations
- Edward Fuller, Senior Vice President - Manufacturing
- Vincent Tyra, President – Activewear Sales
- John Salisbury, Jr, President – Retail Sales

The view of the Chairman at this stage in relation to the Company's strategic change was contained in a letter to shareholders in the 1998 Annual Report:

> *"The restructuring and reengineering we commenced more than three years ago is now essentially complete and fundamental organizational change has begun. I am genuinely excited about many aspects of the year just completed...and the emphasis it puts on the revitalization of Fruit of the Loom. In 1998, the reorganization moved from turnaround to transformation and should ensure that Fruit of the Loom retains its leadership position in*

basic and fashion basic branded apparel, successfully responding to the tremendous challenges that exist today in the apparel industry.

I believe the Fruit of the Loom family of more than 33,500 employees is more focused and capable of expanding and extending our core competencies in basic branded apparel for the entire family. We have asked people to approach problems creatively and they have responded. We now have the nucleus of an organization that can successfully transform Fruit of the Loom into a more consumer driven, product innovative and marketing Company."

8.1.6 Global Company Strategy in 1999

The strategic change initiated in 1996 and pursued in the following years remained in place during 1999. However, 1999 turned out to be a disastrous year for the Company. On the 29th December 1999, the Company filed voluntary petitions for relief from creditors under Chapter 11 of the U.S. Bankruptcy Code (Appendix H (i)). Under Chapter 11 proceedings, FTL, Ltd and FTL, Inc, as debtors and debtors-in-possession, continued to manage and operate their assets and businesses pending the confirmation of a reorganisation plan and were subject to the supervision and orders of the Bankruptcy Court. At the time of filing, FTL's total financing, including secured and unsecured public debt totalled over $1,400 million. What events led to the Company becoming Bankrupt? The Company believed that its vertically-integrated organisation historically made it one of the lowest-cost producers in its industry, and this was the primary basis upon which it competed in the marketplace. To maintain its low cost position, in the face of emerging competition from low-cost countries, the Company relocated substantially all of its U.S. based garment assembly operations offshore. A number of difficulties attended this transition. Prior operating management of the Company had made the decision in early 1998 to reduce inventories, close two distribution facilities and one of its textile plants. The decision to reduce inventory levels was accompanied by the temporary shutdown in the fourth quarter of 1998 of a number of its textile plants. Upon resuming production in the first quarter of 1999, the level of irregular or substandard inventory increased as a result of hiring inexperienced workers. The deficiency in output from the offshore plants coupled with an unexpectedly strong demand for products resulted in shortages of available products, which negatively impacted sales.

The decision to close one of its textile plants extended the time required to produce the necessary inventory to catch up on shortages, and exacerbated the problem. Also, in order to maintain its customer service at acceptable levels, the Company increased its usage of external contractors, overtime labour and expensive methods of transporting materials and products (air freight to reduce lead times), all of which resulted in unfavourable manufacturing variances. The cost overrun in manufacturing alone amounted to over $300 million. Accordingly, the Company's financial performance and cash flow in 1999 reflected these difficulties.

Another factor contributing to the resultant severe liquidity problems was a strategy of diversification pursued in the early Nineties. In 1993 and 1994, FTL had acquired Salem Sportswear, Artex, Pro Player and Gitano Jeanswear, at a total cost of $350 million and primarily financed by debt. These acquisitions were intended to add higher gross margin apparel products to the Fruit of the Loom portfolio. However, none of the businesses achieved the cash flow anticipated at the time of acquisition, which diluted the Company's earnings.

As early as the 1999 first quarter earnings report, problems were becoming apparent. A 10.6% decrease in first quarter sales was reported compared to the previous year. Sales were $408 million for the first quarter ended April 3, 1999 compared to $457 million for the first quarter of 1998. First quarter 1999 operations resulted in a net loss of $9 million, compared to net earnings of $31 million for the first quarter of 1998. In an effort to explain the downturn, the Chairman, CEO and COO, William Farley, commented:

> *"Despite stronger demand for key retail and activewear products, inventory was not available to fulfill the demand. The production adjustments in last year's fourth quarter, principally due to hurricane Mitch and the warm weather that impaired fleece sales, caused greater disruption than we anticipated in planning our first quarter ramp-up schedule. The inability to supply the market demand affected revenues by approximately $45,000,000 for the quarter. These capacity constraints have now been largely resolved, and increased production plans are now being met.*
>
> *Gross profit margins during the first quarter were below last year's margins as the higher cost inventory manufactured in 1998 was sold during the first quarter. However, gross profit margins are expected to improve later in the year with sales of lower cost inventory. Selling, general and administrative expenses were $2,200,000 below last year's first quarter. Continued spending controls more than offset the additional expense required for Y2K remediation. Inventories remain a focus for the organization and were $136,300,000 below last year's first quarter level."*

By the time of the release of second quarter earnings information, things had not improved and the Chairman was coming under increasing pressure from the investment community as well as other Board members. For the six months ended July 3 1999, the Company reported sales of $960 million as compared to over $1,000 million for the same period the previous year. Net loss for the first six months of 1999 was $11.3 million as compared to net earnings of $96.5 million for the same period the year before.

At the time of the earnings release in July 1999, the Chairman stated:

> *"Despite stronger demand for key retail and activewear products, inventory was not available to fulfill the demand. The production adjustments in last year's fourth quarter caused greater disruption than we anticipated in planning our ramp-up schedule for the first six months of 1999. Although the production increases during the second quarter have enabled the Company to make progress in meeting customer demand, the inability to supply the market demand affected revenues by approximately $60,000,000 for the second quarter. Activewear was most affected, as strong seasonal demand in the quarter could not be met with increased production."*

Events in the boardroom also heated up during the first six months of 1999, with William Farley, Chairman, CEO and COO, eventually being ousted from these positions in August and replaced by Dennis Bookshester, who was appointed as Acting CEO and President of the Company. The change at CEO level also heralded the beginning of yet more changes in management at all levels of the organisation. Out went the manufacturing and operations executives, Edgar Turner and Edward Fuller. In came the following executives in September:

- Rick Medlin, Executive Vice President - Manufacturing
- John Matthews, Vice President – Distribution
- Linda Thompson, Vice President – Human Resources

More importantly, the new CEO hired back the former President and COO, John Holland, in October on a consultancy basis initially, although by December he was re-elected to the Board and appointed as Executive Vice President, Operations. Around the same time, the two Sales Presidents left the Company and a new Executive Vice President of Sales, John Wigodsky, was appointed to replace them.

Net Sales for the year 1999 were $1,835.1 million with a Net earnings loss of $576.2 million. Capital expenditure for the year was $34 million.

8.1.7. Global Company Strategy in 2000

With the new management team now in place, the Company set about developing a "Joint Plan of Reorganisation", which set out a schedule detailing how the Company would be restructured, operations rectified and creditors paid. This was a legal requirement under the Chapter 11 code. In 2000, the Company stated in a filing to the Securities and Exchange Commission:

> *"Fruit of the Loom's business strategy is to become the lowest cost producer and marketer of high volume basic apparel and to grow its core business within that segment. Fruit of the Loom plans to continue to focus on the high volume basic apparel market due to its relatively low fashion risk, the relationship it has developed with high volume retailers and wholesale distributors, and the competitive advantage Fruit of the Loom believes it has attained through its low-cost, vertically integrated operations. Management believes that remaining among the lowest cost producers of basic apparel is essential to maintaining and increasing sales and profits. In this regard, Fruit of the Loom's strategy is to continue to implement further cost reduction initiatives through 2000".*

This strategy formed part of the Reorganisation Plan and included the following strategic initiatives:

- Disposal of non-core businesses. The Company divested its previously acquired sports and jeans businesses for $45 million, and eliminated the operating losses generated by those businesses.

- Elimination of unprofitable product Lines. Prior to filing for bankruptcy, the number of style and product variations (Stock Keeping Units or SKU's) offered by the Company had increased as a result of prior management's strategy to introduce higher fashion apparel. The proliferation of SKU's reduced manufacturing efficiency, as average production runs decreased and the number of changeovers increased. In 2000, the number of SKU's was reduced by 40% in order to improve manufacturing efficiencies and refocus production on higher volume products.

- Reduction in fixed costs through consolidation of manufacturing capacity. Four large textile facilities were closed during the year, to realign manufacturing capacity with sales levels. Any future capacity growth would be generated by capital expenditures and efficiency improvements. Some sewing plants in Mexico were also closed for the same reasons.
- Improvements in manufacturing processes and efficiency. The Company implemented a programme of standardisation of manufacturing processes across its plants and improved productivity and efficiencies. It also brought much of the previously contracted-out garment assembly into FTL-owned manufacturing plants in Central America, thereby reducing costs and benefiting from economies of scale within its own plants.

Net Sales for the year decreased to $1,549.8 million with a Net Earnings loss of $126.4 million. The decrease was due to the elimination of non-core product lines and loss of market share in certain market segments. Capital expenditure was down to $26.8 million.

8.1.8. Global Company Strategy in 2001

In 2001, the Company continued to focus on the restructuring of its business. It disposed of non-core operating units and surplus manufacturing facilities in the U.S. and Canada, resulting in 3,298 further job losses during the year. $42.6 million of costs associated with these plant closures were incurred in 2001.

On March 15th 2001, the Company filed an amended "Reorganization Plan" with the Bankruptcy court in the U.S. This plan set out how the Company was being restructured under Chapter 11 protection from creditors, and a timeline for emergence from bankruptcy. During this process, the Company was susceptible to takeover bids by competitors, as the Chapter 11 process allows for any interested parties to bid for the acquisition of the Company. In fact, the U.S. management team was actively seeking a purchaser for the Company who was not a competitor, who would have sufficient funding to purchase the Company, and who would intend to progress with the existing management team.

During the selling process, three competitor companies submitted bids for the Company. These companies were:

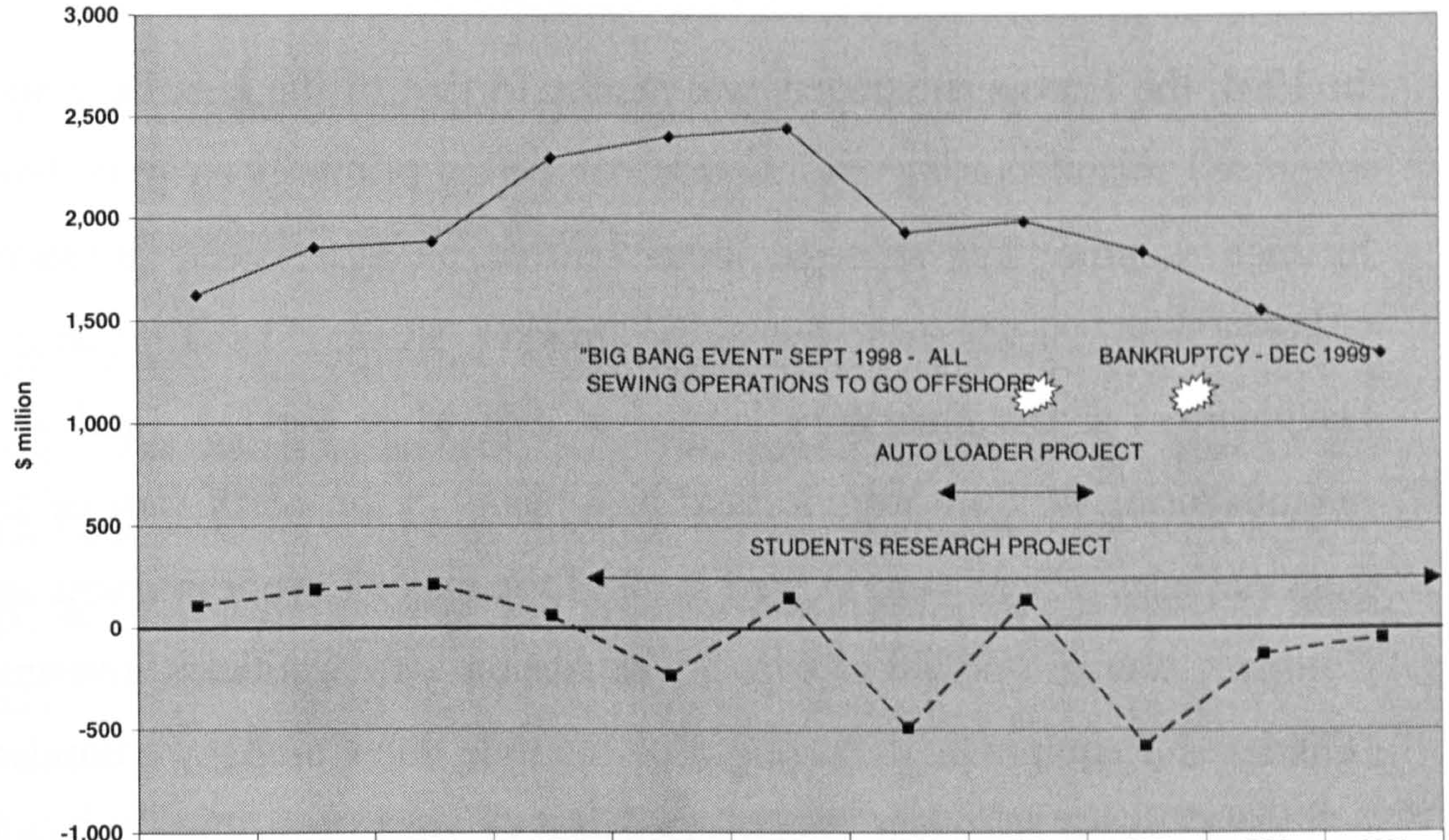
- Gildan, a Canadian apparel manufacturing company bid $600 million
- Russell Corporation, a U.S. based apparel manufacturing company bid $800 million
- Head, a French sports equipment company bid $700 million

Throughout the bidding period, the FTL U.S. management team, led by John Holland, had been working with Warren Buffett, Chairman of Berkshire Hathaway, Inc. in an effort to persuade him to acquire FTL. By November 2001, Berkshire Hathaway, Inc. had agreed to purchase the Company for $835 million, subject to creditor and Court approval. The acquisition of FTL by Berkshire Hathaway was completed on 30th April 2002.

Net Sales for 2001 decreased to $1,341.8 million, with a Net Earnings loss of $46.6 million. The decrease in net sales was primarily due to a decreased market share in the activewear market segment, where sales declined 24.5% or $115 million compared to 2000.

8.1.9. Summary of FTL Inc Earnings Performance

As is evident from a review of the Company's strategy covering the period 1994 to 2001, many significant changes occurred in the business coupled with multiple changes at executive level. These executive level changes in themselves usually predicated a change in strategy. Although the acquisitions of companies in the early to mid nineties yielded an initial growth in sales, their financing and exiting costs had a major detrimental effect on the financial performance of the Company. The impact of these strategic change events on Net Sales and Net Earnings for the period 1991 to 2001 is shown in Figure 8.1. Also illustrated in this figure are timelines showing the period of the student's research project, the automatic loader project, and the "big bang" strategic change event of the decision to move all sewing operations in Europe off-shore.



	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
—◆— Net Sales	1,628.1	1,855.1	1,884.4	2,297.8	2,403.1	2,447.4	1,931.2	1,984.8	1,835.1	1,549.8	1,342
-■- Net Earnings	111.0	188.5	212.8	60.3	-232.5	146.6	-487.6	135.9	-576.2	-126.4	-46.6

Year

Figure 8.1: Net Sales and Net Earnings for Fruit of the Loom during the period 1991 to 2001.

The various changes in management that took place and the resultant changes in strategy ultimately led to the Company filing for bankruptcy in December 1999, when the Net Earnings loss for the year was $576.2 million.

8.2 European Strategy

Fruit of the Loom's European operations accounted for between 10% and 15% of the total Company Net Sales during the period 1994 to 2001. Throughout this period the Company maintained its position of having the highest market share for its basic Tee shirt and sweatshirt products across Europe, selling as many as 80 million units per year which equated to just over 20% of the total market.

8.2.1 European Strategy in 1994

In 1994, the European strategy was similar to that of the U.S. i.e. a vertically integrated manufacturing organisation competing primarily on price leveraged by high volume. The strategic focus centred on aggressively growing sales volumes and significantly increasing market share. The European Sales headquarters at the time were located at Telford in the U.K. and all of its manufacturing facilities were located in 8 plants in the north west of Ireland. Regional sales offices were located in all of the major European countries. The Company was in a period of capacity expansion with significant investment in facilities and equipment occurring. For example, the Company commissioned two new sewing plants in County Donegal in 1994. These new plant builds followed on from previous capital investments in 1991 when a new Spinning Mill was opened in Campsie, N.Ireland at a cost of $60 million and in 1993 when a new Dyeing Plant was built in Buncrana, County Donegal at a cost of $20 million. The early Nineties saw significant investment in manufacturing and business growth in the European operations.

In 1994, the European management team comprised the following people:

- Jean Gariepy, President Europe
- William McCarter, Managing Director
- Len Marbury, CFO, Europe
- John McCarter, Director, Sales and Marketing
- Ray Barnes, VP Imprint Sales
- Andrew McCarter, Director, Manufacturing

- Mary Cullen, Director of Product Development
- Seamus McEleney, Finance Director
- Charles Donaghey, Logistics Director

Gariepy, Barnes and Marbury were based in England and the remaining managers were based in Ireland. The Irish based managers were part of the original family owned company that had formed a joint venture with FTL in Europe in 1987, with the three McCarter brothers central to the running of the business.

Another significant event in 1994 was the establishment of a formal Research & Development department in Ireland. This was set up with the aim of furthering the Company's technical capability in manufacturing and was also charged with the overall responsibility for manufacturing technology acquisition activities. This is covered in more detail later in this chapter.

In 1994, the net sales in Europe were $218 million, having grown from $129 million in 1991. Net earnings were $22 million.

8.2.2 European Strategy in 1995

In 1995, FTL Europe continued with the same core business strategy aimed at growing revenues through capturing increased market share. The Company had sufficient manufacturing capacity to meet the increasing sales volumes through its prior strategy of capital investment programmes in facilities. This proved to be a very successful strategy as Net Sales increased by 24% during 1995. In order to better service the European market, the Company opened a new Distribution Centre in Kaiserslautern, Germany during the year. This Centre became the main warehouse for finished products and was capable of holding

18 million units. Prior to this, all shipping of goods to customers was handled by warehouses in England and Ireland only.

In terms of the organisation structure, any change in the U.S. management structure usually heralded a subsequent change in management in Europe. In late 1995, two significant changes in senior management occurred with the appointment of the following executives:

- Bernard Hansen, President Europe
- Henry Rauzi, Chief Financial Officer, Europe

So out went Jean Gariepy. The senior executives in Ireland remained in their positions.

Net Sales for the year had increased to $271 million, however net earnings dropped to a $19 million loss.

8.2.3 European Strategy in 1996

The new President and CFO spent much of 1996 reviewing both the overall European strategy and key functional areas of the business including manufacturing, sales, information technology and finance. Key outputs from this assessment included the following strategic decisions and restructuring actions:

- Commence the relocation of some sewing operations from Ireland to Morocco to avail of lower cost labour. At the time, this strategy was seen as implying the potential closure of up to 6 sewing plants in Ireland with the possible threat of up to 1800 jobs losses. However, only tee shirt sewing plants were to be moved at this time, leaving the sweatshirt sewing plants in Ireland. It was thought that the automated sewing department would remain in place in Ireland as it was involved in only the first stages of garment assembly (e.g. sleeve sub-assembly) and so would not be impacted by the announcement. Investment in this process area continued through 1996.

- A new Management Information Systems (MIS) centre was established in Gent, Belgium with the relocation of core IT jobs from Ireland. (The new CFO had previously worked with an IT Director who happened to live in Belgium).
- Relocation of some key finance jobs from Ireland to England where the CFO was based.

During the year, the CFO was also appointed as Chief Operating Officer (COO) for Europe and was given additional responsibilities over and above Finance, including Logistics, Product Development, IT and even more significantly, Manufacturing. This created a lot of issues for the Irish based management team as they saw it as undermining their position and thus began a period of internal political wrangling and posturing. Traditionally, they had reported to the Irish based Managing Director, William McCarter, but now some of them reported directly to the COO in England. Additionally, the Irish based team had always focused on growing employment numbers in Ireland, with the support of the Irish Government, so with these changes in both strategy and organisation, there was much internal conflict. To illustrate this, the Company was close to completing the building of a new sewing facility in Dungloe, West Donegal when this change in sewing strategy was implemented. This project, which was Government had funded, was cancelled a matter of weeks before the factory was due to open, causing much embarrassment for local management. At the time, FTL were one of the largest employers in Ireland and had a high profile in the media.

Towards the end of 1996, these internal tensions were further heightened when a downturn in third and fourth quarter sales, coupled with a desire by the COO to reduce inventories before year end resulted in a lengthy period of short-time working and layoffs at the Irish manufacturing plants. This was even raised as an issue in the Irish Parliament at the time (Appendix H (ii)) causing even more internal conflict. It is important to state that the Managing Director, William McCarter, at this time was also Chairman of the International Fund for Ireland (IFI), a body set up by the British, Irish and American governments to promote job creation in Ireland through government funded investment. The directors of the Company in Ireland were also family members of the original McCarter Textile Company, and saw their role partly as providing employment, and were somewhat active on the media scene.

The European operations returned to profitability despite the internal issues, with Net Earnings of $24 million. However, Net Sales had declined to $264 million from $271 million the previous year.

8.2.4 European Strategy in 1997

The strategy in 1997 remained consistent with previous years in so far as the focus was on growing the business and competing in the marketplace primarily on cost. However, the disputes in the boardroom continued, culminating in the dismissal of three of the Irish management group in August of that year, namely the Managing Director, the Sales Director and the Finance Director. Their departure was particularly acrimonious and ended up in the High Court in Dublin, with lawyers battling over severance terms, before ultimately reaching a settlement (Appendix H (iii)). As a consequence of these departures, the following appointments were made:

- Andrew McCarter, Vice President, European Manufacturing & Sourcing

- Joe Mullan, Director of Manufacturing, Sewing
- Kenny Rutherford, Director of Manufacturing, Yarn & Textiles
- Mary Cullen, Director, Quality & Product Development

The VP Manufacturing reported directly to the COO Europe, Henry Rauzi, and the other three appointees reported to the VP Manufacturing.

Meanwhile, the business in Europe was not performing as anticipated and there was a further decline in sales compared to 1996. Net Sales for the year decreased to $254 million and more significantly there was a Net Earnings loss of $24 million. These results brought a lot more focus on the European operations by the U.S. Parent Company.

8.2.5 European Strategy in 1998

1998 was to be a pivotal year for FTL Europe. First quarter turnover and earnings continued to decline and the patience of the U.S. management concerning attainment of results despite all of the restructuring efforts, was running out. They also began to question the business strategy in Europe from the aspect of being a low cost, high volume producer with a strong manufacturing orientation. This was being challenged as the U.S. strategy from 1996 to 1998 was to transition to a marketing-led company, so why not Europe too, especially given the downward sales trend and poor financial results?

This view would ultimately prevail when in February 1998, Felix Sulzberger was appointed as the new President of the European business. He had previously been President of the Levi Strauss Jeans company in Europe and his business philosophy was based around a marketing-led approach. His arrival signalled the departure of the previous president, Bernard Hansen. The new president was a Swiss national and one of the conditions of him taking up the post was that he be allowed to establish a new European headquarters for FTL in Switzerland. A new large office complex was set up in Zug, about 60km from Zurich in mid 1998, and the COO, Henry Rauzi, relocated from the U.K to Zug too.

On the 22nd June 1998, fifty-four senior managers from across Europe were invited to a two-day conference in Switzerland, where the new strategy for FTL Europe was unveiled. The conference was entitled "Strategic Direction 1999 – 2005" and was led by the new European president. The "new" strategy indeed included the transition to a marketing-led company, whereby the Company's brand and products would be positioned "up-market" yielding higher margins that were projected to ultimately lead to increased revenues and higher earnings. Both the president and many of the participants regarded this strategic direction as a fundamental change for the Company. Achieving this strategy would require major changes in the Company's sales channels and customer base. The downside was that it would take a number of years to complete this transition and during this period, turnover and earnings would at best be stable, but would most likely decline further in the short term.

The President set about making yet more senior management changes in the organisation, including the following appointments during 1998:

- Rosie Gaebke, Vice President, Retail Sales
- Claude Flauraud, Vice President, Imprint Sales
- Mike Ehmes, Vice President, Logistics
- Heike Heppe, Merchandising & Marketing Director
- Dave Mulder, Chief Financial Officer

- Joe Mullan, VP Manufacturing
- Caterina Hochstrasser, Human Resources Director

With the exception of the VP Manufacturing, all of these positions were located in Switzerland. Also, the first three new VP's above had previously worked with the President at Levi Strauss. The above appointments also meant that the following people exited the Company:

- Henry Rauzi, COO & CFO
- Andrew McCarter, Vice President, European Manufacturing & Sourcing
- Kenny Rutherford, Director of Manufacturing, Yarn & Textiles
- Mary Cullen, Director, Quality & Product Development
- Ray Barnes, VP Imprint Sales
- Charles Donaghey, Logistics Director

In October of 1998, three additional directors were appointed to the Irish based manufacturing group to work alongside Joe Mullan:

- Michael Mallon[3], Technical Director
- Liam Tourish, Production Director
- Kevin Conaghan, Finance Director

So 1998 in Europe saw significant restructuring of management and a major strategic change in direction of the Company. Only senior management

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[3] The author

changes are discussed here, but there were many changes too at a middle management level during this period.

Another key event in 1998 was the announcement of the closure of a further three sewing plants in Ireland, with the loss of over 700 jobs. These were the sweatshirt plants that had not been affected by the initial plant closure announcements in 1996. It was planned to relocate these sewing jobs and associated capacity to the already established Moroccan operations. The Company Chairman, Bill Farley, and some of his management team announced this “big-bang” strategic change event when they visited Ireland in September 1998.

The proposed restructuring did not have a negative impact on earnings during 1998, but would flow through and impact significantly the following year. The Net Sales had risen to $269 million generating Net Earnings of $29 million.

8.2.6 European Strategy in 1999

In 1999, the new European management team set about executing the revised strategy, particularly in the Retail sector where the branded product was sold. This market accounted for about 30% of the annual sales volume, with all products bearing the well-known Fruit of the Loom brand logo. The primary retail channels for these products at that time were large hypermarket chains such as Makro and Tesco. However, the revised strategy involved closing down these accounts and selling the product ranges into more “up-market” stores across Europe. To further support this strategy, it was decided that the quality of some FTL own-manufactured product was not of the required standard for these new customers, and a decision was taken to outsource a significant proportion of these products from the Far-east.

In the first quarter of 1999, with the closure of the three Irish sewing plants, much of manufacturing management's focus was on building up the additional capacity in the three Moroccan plants. However, the ramp-up in production output did not go as quickly as expected and this resulted in a shortfall in supply of finished goods to customers, particularly the new Retail customers. Likewise, there were delays in bringing in outsourced products from the Far East. These problems were compounded by significant errors in the forecasting and planning functions, leading to the recently appointed Logistics Director [Mike Ehmes] losing responsibility for planning. The change in product ranges to meet the requirements of the new customers resulted in millions of units of "discontinued" product ending up as obsolete inventory, requiring significant write down provisions. The business outlook in Europe had very quickly deteriorated and this created a great deal of friction between the Chairman, Bill Farley, and the European President, Felix Sulzberger. Sulzberger was standing by his business strategy and team, whilst the U.S. Chairman was becoming increasingly agitated by the projected financial losses, estimated by mid-year to be in the region of $30million for the European business alone. As a reaction to some of the events, the European President made the following organisation changes in an effort to resolve some of the business problems:

- Michael Mallon, Director of Planning, Europe[4]
- Mike Ehmes, Director of Distribution, Europe
- Heike Heppe, Director of Sourcing, Europe

In June, the senior management team from Europe was requested to attend a business review meeting with the Chairman and key management in the U.S. operating headquarters in Kentucky. This review meeting lasted two days and was focused on the projected poor financial performance in Europe. The Chairman commented that the strategy was "failing" and that the European business was "out of control". There was a significant amount of open conflict between the Chairman and the European President, as well as between some of their respective managers.

The Management team returned to Europe, where the VP Imprint Sales, Claude Flauraud, resigned after only six months with the Company. The Chairman selected his replacement, Robert Blankenship, from within the organisation in the U.S, much to the dismay of the European President. A meeting of European management had been scheduled much earlier in the year to take place in Kaiserslautern in July. Most of the senior managers had made arrangements to be there. The week preceding the meeting, the European President had issued the agenda topics and detailed the areas to be reviewed.

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[4] The author had reluctantly to accept promotion from Technical Director to Director of Planning, because the Company felt it needed someone to tackle the serious production scheduling issues which were damaging the European business. This involved the author working at the Company's European headquarters in Switzerland over much of the next twelve months, and being absent during the latter stages of the trials on the auto loader machine. This was also a partial cause of the thesis extending to almost seven years. An effect was that the second round of interviews on the auto loader case took place several months after project termination, when a number of participants had since left the Company. It is felt that the findings are not materially altered by this factor, a reasonable amount of data having been obtained from the players still present at the second round of interviews. In January 2000, the author returned to a manufacturing role as Manufacturing Director for the textile operations in Ireland. A benefit from this period in planning however was that the researcher gained exposure to European board level decision making processes, and was able to accumulate the data about the development of strategy at corporate level, which forms the basis of this chapter.

However, on the morning of the meeting, the Chairman walked into the meeting unexpectedly, accompanied by Bernard Hansen, a previous European President. The Chairman announced that Felix Sulzburger's employment had been terminated and that Bernard Hansen was rejoining the Company as the new European President. The atmosphere at the meeting was extremely tense and there was almost a sense of shock at what was happening. Hansen stated openly that the strategy pursued by Felix Sulzburger was "disastrous" and that FTL Europe would go back to selling into the mass-market channels, which had driven business growth in previous years. Thus, there was a U-turn in the business strategy.

Further changes in management were again inevitable as a result of the of a new European President being appointed, and included:

- Matthias Koerner, Vice President Retail Sales, replacing Rosi Gaebke whose employment was terminated in September
- Sal Consiiglio became Vice President, Imprint Sales, Northern Europe having moved from FTL U.S.
- Caterina Hochstrasser, HR Director, had her employment terminated

This was not the end of the changes in 1999. In December, the European President, Bernard Hansen left the Company after only six months and the then CFO, Dave Mulder, was charged with managing the business and was appointed to the position of Executive Vice President of Europe. In Ireland there were two new appointments to the board of directors:

- Eugene McIlroy, Human Resources Director
- Martin Quigley, Quality Assurance & Product Development Director

With the bulk of the Swiss based team now gone, a decision was made to close down the expensive headquarters in Switzerland and relocate it to Telford in the U.K. and this happened at the end of 1999.

The major change in strategy embarked upon in early 1998 and its associated cost to implement caught up with the Company in 1999. Net Sales decreased to $213 million resulting in a Net Earnings loss of $55 million. This decrease in earnings was mainly due to the change in strategy that had been pursued by Sulzberger. As was the case in the U.S., the European operations were in trouble too.

8.2.7 European Strategy in 2000

The year 2000 again began with yet another relatively new management team and against the backdrop of the Company being in Chapter 11. The new sales team set about trying to regain a position in the mass-market channels and stores that they no longer had accounts with, because of the previous strategy. This proved to be extremely difficult as relationships had to some extent been soured by FTL pulling out of the stores in the previous year. It was taking time to rebuild relationships and to get customers to again place orders with the Company as they had now found other suppliers of similar products. However, aggressive pricing meant that at least some headway was being made.

Dave Mulder, the new Head of Europe, started the year of by making yet more management changes:

- Sal Consiglio became Vice President, Imprint Sales, replacing Robert Blankenship, whose employment was terminated
- Michael Mallon became Manufacturing Director, Textiles
- Liam Tourish became Manufacturing Director, Apparel

- Terry Melaugh became Planning Manager Europe

In March, the new U.S. COO, John Holland, and some of his team arranged a meeting of key European managers in the Telford, U.K. offices. Twenty minutes before the meeting was due to commence, the Executive Vice President of Europe, Dave Mulder, had his employment terminated and left the building immediately. John Holland, entered the meeting room accompanied by some of his U.S.-based team and some new European managers. He proceeded to make the following appointments at the meeting:

- Len Marbury, Senior Vice President Finance & Operations
- Art Kirby, Senior Vice President Sales & Marketing
- Joe Mullan, Senior Vice President Manufacturing

He explained that these three people would have joint responsibility for running the European business, reporting directly to corresponding heads of function in the U.S. Len Marbury had previously been with the Company in Europe as CFO and was thus being reinstated some years after having had his employment terminated.

The COO outlined that the vision he had for the European business was one of growth through the same strategy as the U.S. Parent Company, that of low-cost producer of basic family apparel for the mass markets. He emphasised the need for continuous reductions in costs to enable the Company to be more competitive in the marketplace in pursuit of this strategy. He also gave an overview of the plans the Company had in the U.S. and the strategy being undertaken in an effort to re-emerge from bankruptcy.

Net Sales for the year had declined even further to a low of $174 million but more importantly the loss of the previous year had been turned around with a Net Earnings loss of only $2.6 million.

8.2.8 European Strategy in 2001

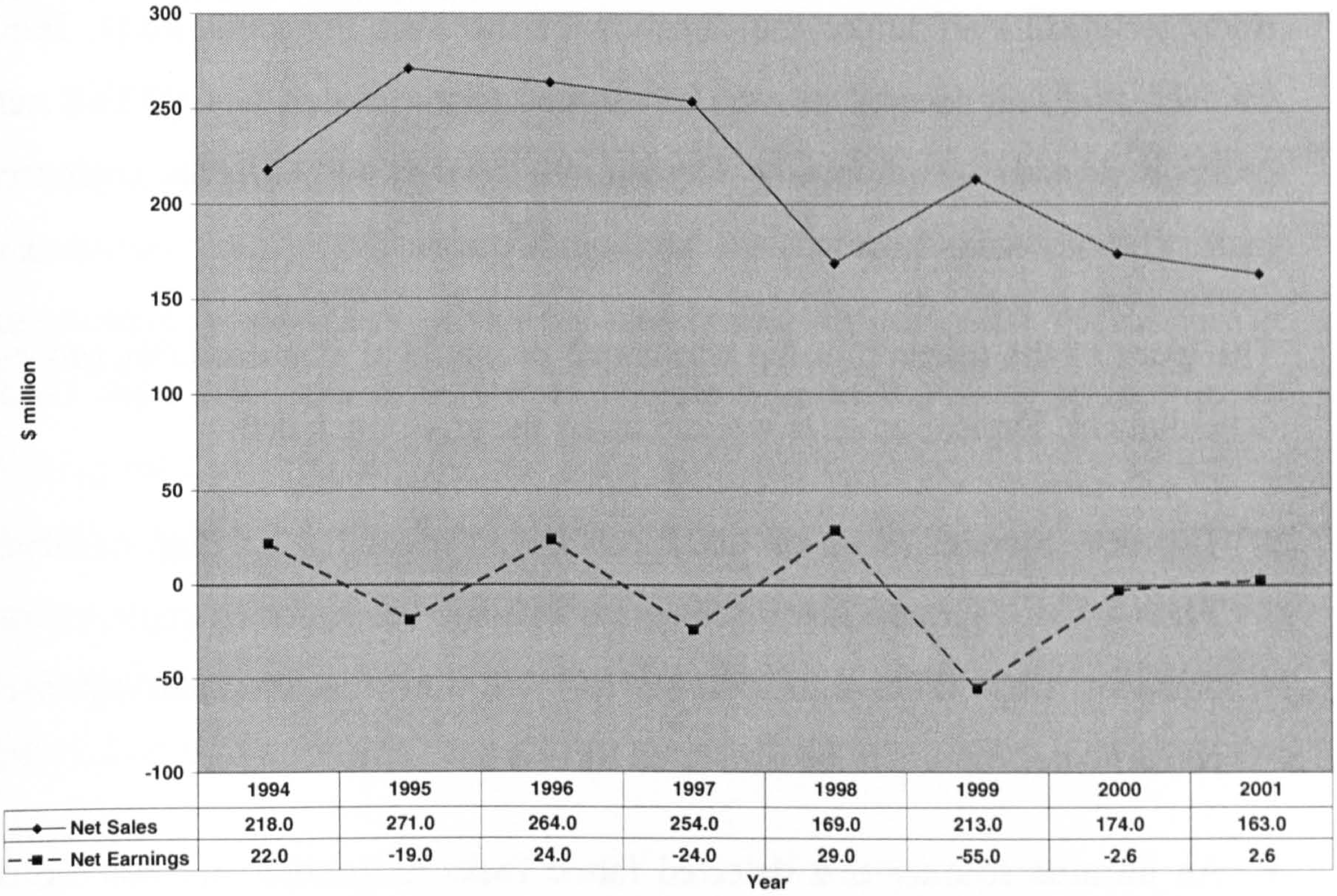
The three Senior VP's changed some key management positions early on in the year:

- Sergio Nannini became Vice President Sales, Southern Europe, replacing Matthias Koerner who left the Company
- Liam Tourish became Director of Sourcing, replacing Heike Heppe, whose employment was terminated
- Mike Ehmes, Logistics Director, had his employment terminated

These were the only senior management changes made during the 2001. and some stability appeared to be returning in terms of management tenure. Meanwhile, the business too seemed to be stabilising and the Company's strategy seemed to be working as for the first time in a number of years, the European business returned a profit. The financial reports indicated Net Sales of $176 million and Net Earnings of $2.6 million. Moreover, approval was given for a number of major manufacturing projects in Ireland including the consolidation of the Republic of Ireland textile operations onto a single site, which involved substantial capital investment.

8.2.9 Summary of FTL Europe Earnings Performance

The review of the Company's European operations mirrors that of the corporation as a whole. It underwent continuous changes in personnel at executive level, which in turn drove different business strategies. However, the common thread was that an analysis of Net Earnings on a cumulative basis would yield a major loss. The Net Earnings and Net Sales for Europe from 1994 to 2001 are shown in Figure 8.2.



	1994	1995	1996	1997	1998	1999	2000	2001
—◆— Net Sales	218.0	271.0	264.0	254.0	169.0	213.0	174.0	163.0
– ■ – Net Earnings	22.0	-19.0	24.0	-24.0	29.0	-55.0	-2.6	2.6

Figure 8.2: Net Sales and Net Earnings for Fruit of the Loom Europe during the period 1994 to 2001.

8.3 Impact of Corporate Strategic Changes on Research & Development Activity in FTL U.S.

FTL U.S. had established a formal R&D department at its headquarters in Bowling Green, Kentucky in the early 1980s. The R&D group comprised about thirty technical staff under the direction of the Vice President R&D, Hank Cantrell, and was located in a 50,000 square foot research facility. The staff group was made up of mainly electrical, mechanical and software engineers, most of whom had at least masters' level qualifications.

The work of the research group was aimed primarily at manufacturing process development. Typical projects worked on by the group included:

- The development of an on-line monitoring system for knitting machines. This system captured key machine performance data, for example, r.p.m., machine stop time, and output, and allowed machine and operator performance reports to be generated by users.

- An infrared scanner that detected fabric faults in knitting and that would automatically stop the machine when a flaw was detected.

- Automated sewing equipment for garment assembly.

- Automated materials handling equipment to support existing off-the-shelf sewing equipment. For example, they developed a device for automatically positioning a Tee shirt pocket to the head or needlepoint of a standard industrial sewing machine.

- A digital camera system, which detected the width of fabric passing through a textile machine and adjusted the machine automatically when the fabric width went outside of the allowed tolerance.

A large proportion of the department's work in the Nineties was centred on process development work to improve sewing operations through the automation of the manual handling elements of certain sewing jobs. The ultimate aim of any of these developments was to reduce the cost of garment assembly through automation.

The R&D Centre had originally been established by John Holland when he was President, but when he left the Company in 1996 the activities of the R&D department went under scrutiny. It had previously operated fairly autonomously and the projects were mainly determined by the VP R&D. The R&D department did not have to operate as a business unit with a profit making requirement, rather it was seen more as a necessary support or service function within the overall corporation. However, with the change in strategy to relocate sewing to Central America, a significant proportion of its work was no longer required as the automation of sewing operations could no longer be justified on a cost-benefit basis due to the relatively low labour costs attainable off-shore.

The R&D group tried to react to this internal threat posed to its very existence by switching focus entirely to textile-related projects. However, this change in R&D strategy proved to be insufficient to ensure its survival. With the ever worsening financial performance of the Company and with the departure of R&D department's founder, John Holland, the U.S. management made a decision to close down the R&D Centre. This closure occurred during the period June to September 1998.

8.4 Impact of Strategic Changes on Research & Development Activity and Manufacturing Technology Acquisition in FTL Europe.

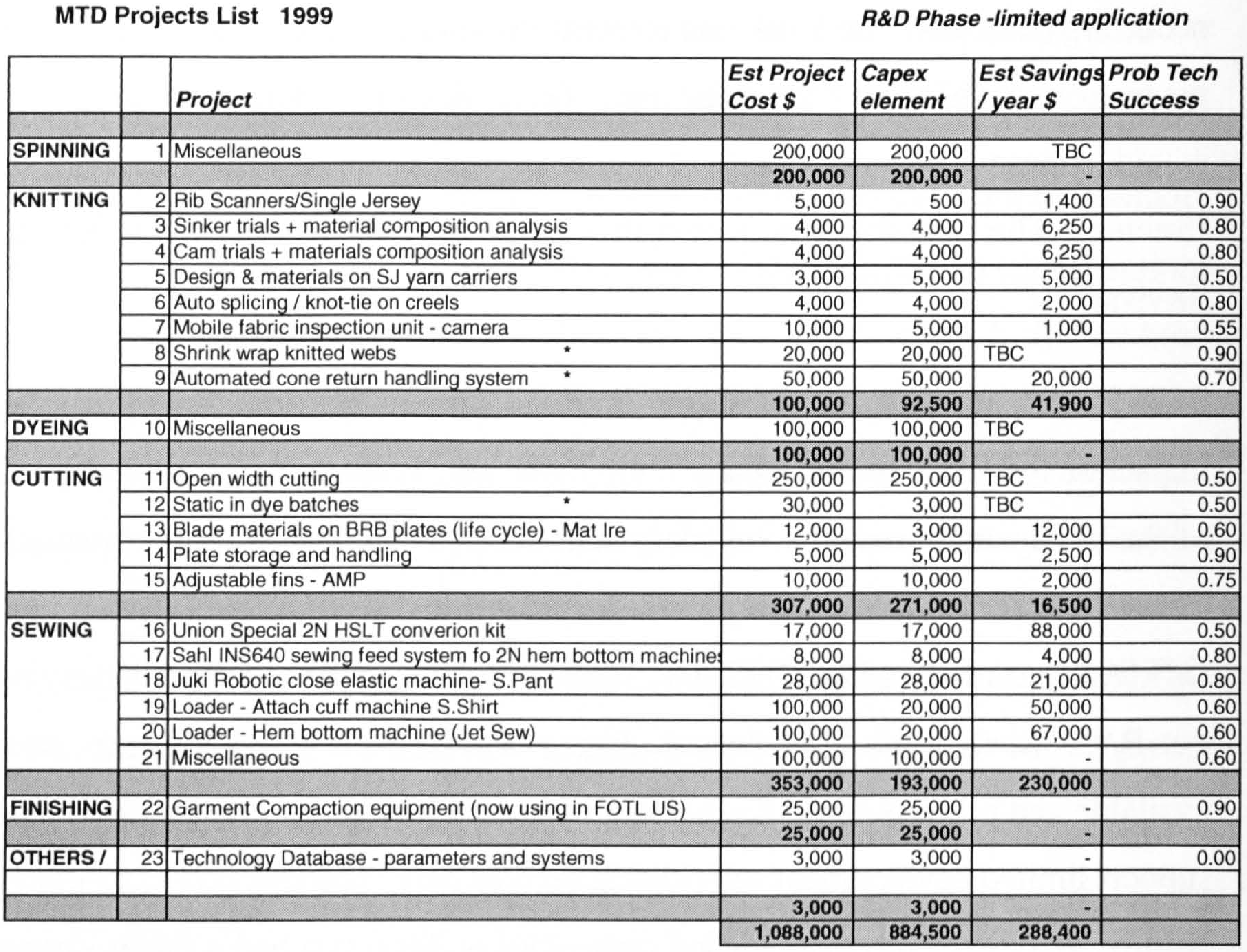
The European R&D department had been established in 1994 with the primary objective of carrying out R&D work to support the manufacturing operations in Europe. As in the USA, most of the department's work focused on manufacturing process development as opposed to product development activities. Previous chapters of this thesis have dealt with typical projects and the project portfolios managed by the department. One distinct difference between the U.S. R&D operation and the European one was that the Ireland-based R&D group had primary responsibility for acquiring all manufacturing technology, whether outsourced or developed in-house, so its scope of activities was much broader.

During the period 1994 to 1998, the R&D group had developed its own novel approaches to acquiring technology using portfolio management techniques as described in earlier chapters. It operated independently of the U.S. R&D department although there was a sharing of project lists to ensure that no duplication of effort was taking place. There was also the occasional secondment of personnel to the U.S. to assist with specific projects. Nevertheless there was no direct formal association between the two centres.

The strategic changes happening in the business in both the U.S. and Europe were to have a significant impact on the Irish R&D department, as was exemplified by the Automatic Loader case study. During the period 1994 to 1998, the R&D department in Ireland had operated very successfully and had become well integrated with the manufacturing operations. It was also well supported financially and its staff numbers had grown to around fifteen. In 1998, local management in Ireland became aware of the imminent closure of the R&D department in the U.S. As a tactic to try to avoid a similar fate occurring in Ireland, the local management decided to change the department's name from "R&D" to "Manufacturing Technology Development", so that it would appear more favourably if someone was to review the organisation structure. The question was would this single tactic be enough to ensure its survival?

In 1998, the appointment of a new President in Europe was also to have an impact on the R&D activity. Early on in his tenure, he undertook a review of all of the European operations including manufacturing and its support structures. This ultimately led to a review of the Manufacturing Technology Development (MTD) department in late 1998. The President questioned the need for carrying out R&D work at all, but to some degree was satisfied that if finances were available and projects could be justified by their return on investment, he would support limited development activities in textiles only. The change in strategy in Europe in 1998 to move all sewing operations to Morocco had a major impact on the MTD project portfolio, realigning and reducing the scale of the work. The fact the MTD department was also responsible for acquiring all manufacturing technologies, new and proven alike, and for their deployment through all of the plants, also helped.

In August 1998, the MTD department had compiled its proposed project list of 1999 projects in line with the normal timing of project proposal developments. The proposed projects are shown in Table 8.1.



MTD Projects List 1999 *R&D Phase -limited application*

		Project	*Est Project Cost $*	*Capex element*	*Est Savings / year $*	*Prob Tech Success*
SPINNING	1	Miscellaneous	200,000	200,000	TBC	
			200,000	**200,000**	-	
KNITTING	2	Rib Scanners/Single Jersey	5,000	500	1,400	0.90
	3	Sinker trials + material composition analysis	4,000	4,000	6,250	0.80
	4	Cam trials + materials composition analysis	4,000	4,000	6,250	0.80
	5	Design & materials on SJ yarn carriers	3,000	5,000	5,000	0.50
	6	Auto splicing / knot-tie on creels	4,000	4,000	2,000	0.80
	7	Mobile fabric inspection unit - camera	10,000	5,000	1,000	0.55
	8	Shrink wrap knitted webs *	20,000	20,000	TBC	0.90
	9	Automated cone return handling system *	50,000	50,000	20,000	0.70
			100,000	**92,500**	**41,900**	
DYEING	10	Miscellaneous	100,000	100,000	TBC	
			100,000	**100,000**	-	
CUTTING	11	Open width cutting	250,000	250,000	TBC	0.50
	12	Static in dye batches *	30,000	3,000	TBC	0.50
	13	Blade materials on BRB plates (life cycle) - Mat Ire	12,000	3,000	12,000	0.60
	14	Plate storage and handling	5,000	5,000	2,500	0.90
	15	Adjustable fins - AMP	10,000	10,000	2,000	0.75
			307,000	**271,000**	**16,500**	
SEWING	16	Union Special 2N HSLT converion kit	17,000	17,000	88,000	0.50
	17	Sahl INS640 sewing feed system fo 2N hem bottom machine	8,000	8,000	4,000	0.80
	18	Juki Robotic close elastic machine- S.Pant	28,000	28,000	21,000	0.80
	19	Loader - Attach cuff machine S.Shirt	100,000	20,000	50,000	0.60
	20	Loader - Hem bottom machine (Jet Sew)	100,000	20,000	67,000	0.60
	21	Miscellaneous	100,000	100,000	-	0.60
			353,000	**193,000**	**230,000**	
FINISHING	22	Garment Compaction equipment (now using in FOTL US)	25,000	25,000	-	0.90
			25,000	**25,000**	-	
OTHERS /	23	Technology Database - parameters and systems	3,000	3,000	-	0.00
			3,000	**3,000**	-	
			1,088,000	**884,500**	**288,400**	

Table 8.1: MTD proposed/ original project list for 1999, prior to the change in strategy. The three projects that survived the MTA budget cuts are denoted with a '*'.

The European management changes that occurred in October 1998 had a major impact on this proposed project portfolio. The automated sewing projects planned for 1999 were no longer appropriate given the change in strategy. Also, around the same time the Automated Loader project, which was the subject of the previous chapter, was terminated. The original MTD project list totalled just over $1 million for the 23 listed technology acquisition projects, including the six sewing projects. It was envisaged late in 1998 that this money would still be available for projects, with the finance for the sewing projects being reallocated to other textile projects. However, this turned out not to be the case.

In January 1999, alongside the closure of the sewing plants in Ireland, the European President had reviewed the overall cost of the support functions in Ireland and gave a directive that the number of people in the MTD department should be reduced from fifteen to six. A list of those being made redundant was drawn up by the MTD Manager [Catriona Kelly] and those people were informed of the decision. Examples of key jobs eliminated from the department included:

- R&D Manager, Dyeing
- R&D Manager, Knitting
- Technical Manager, Sewing
- Automation Engineer, Sewing
- Mechanical Engineer, Sewing
- Electronics Engineer, Sewing
- Process Engineer, Knitting

This was a major blow to the department and meant that the previous number of projects being undertaken by the department was no longer possible, because of the reduced resources. The department in early 1999 comprised only the following personnel:

- MTD Manager
- Project Engineer, Electronics
- Project Engineer, Mechanical

- Project Engineer, Cutting & Sewing
- CAD Operator
- Manufacturing Systems Engineer.

Only three projects were worked on in 1999, and the total direct costs budget for development projects was kept at less than $100,000 instead of the original plan of over $1 million. Likewise, capital expenditure was restricted to a total of $3.5 million, further minimising the activities of the group. The department's operating budget had now reduced to only $300,000, mainly as a result of the reduction in manning. The department struggled for survival during this period and its strategic direction was not the most important issue – the only real strategy at the time was one of survival for the unit. The projects undertaken were:

(1.) The acquisition of a shrink-wrap machine for knitting (Figure 8.3)

(2.) An automated handling system for returning cones in knitting

(3.) A mechanism for reducing the impact of "static" in the cutting process

The year 2000 turned out to be similar. There was limited finance available to support projects because the Company was in bankruptcy. Only three development projects were undertaken in 2000 with a total spend of $230,000. The projects carried out were:

(1.) Liquid heating & cooling system for compactor machines used to preshrink fabric after the dyeing process (Figure 8.4)

(2.) Quadrant automatic adjustment equipment for compactor machines for changing parameter settings.

(3.) A specially designed hoist for lifting cylinders from knitting machines during machine set-up.

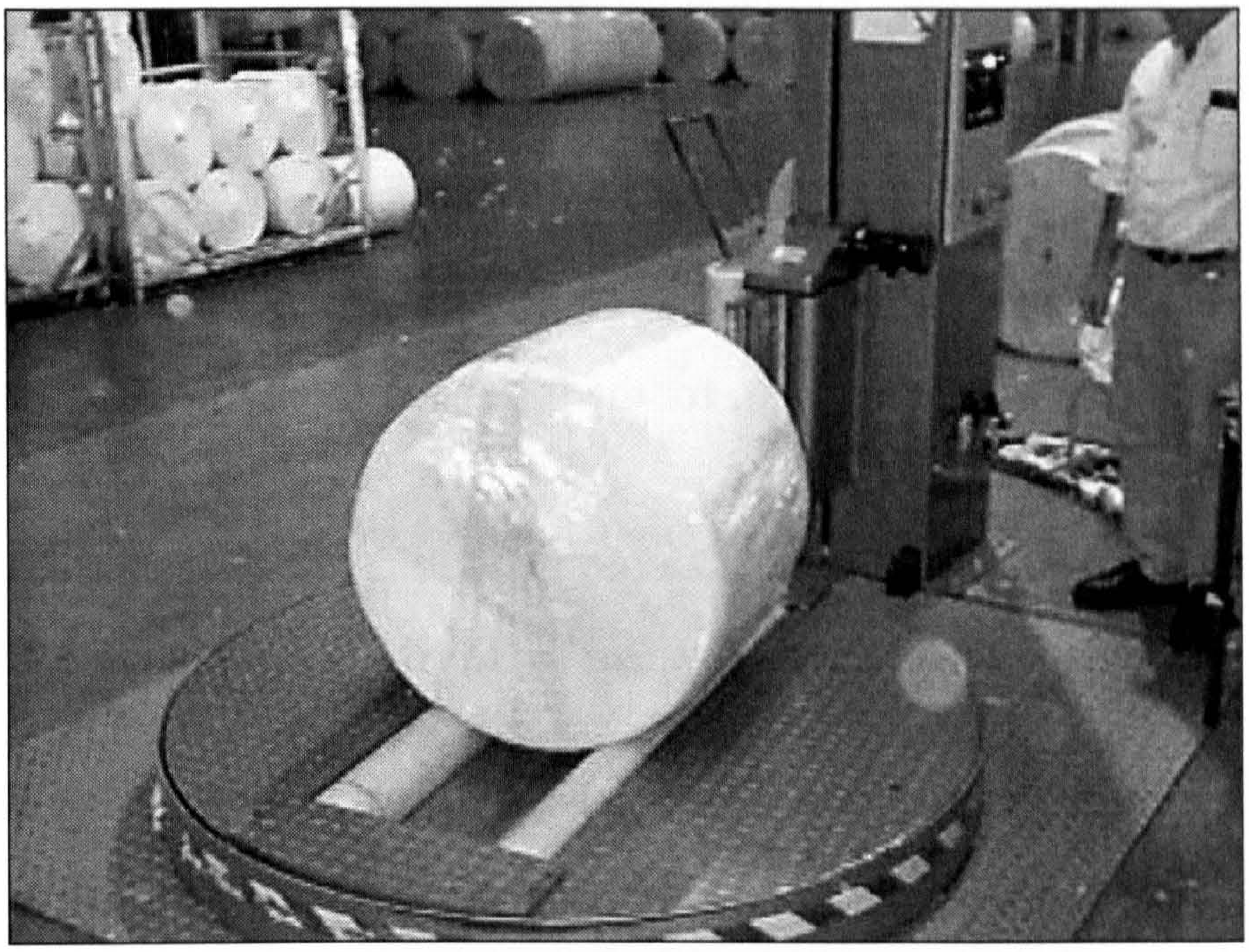


Figure 8.3: A shrink-wrap machine for protecting rolls of fabric in knitting. This was one of only three MTA projects undertaken in 1999.

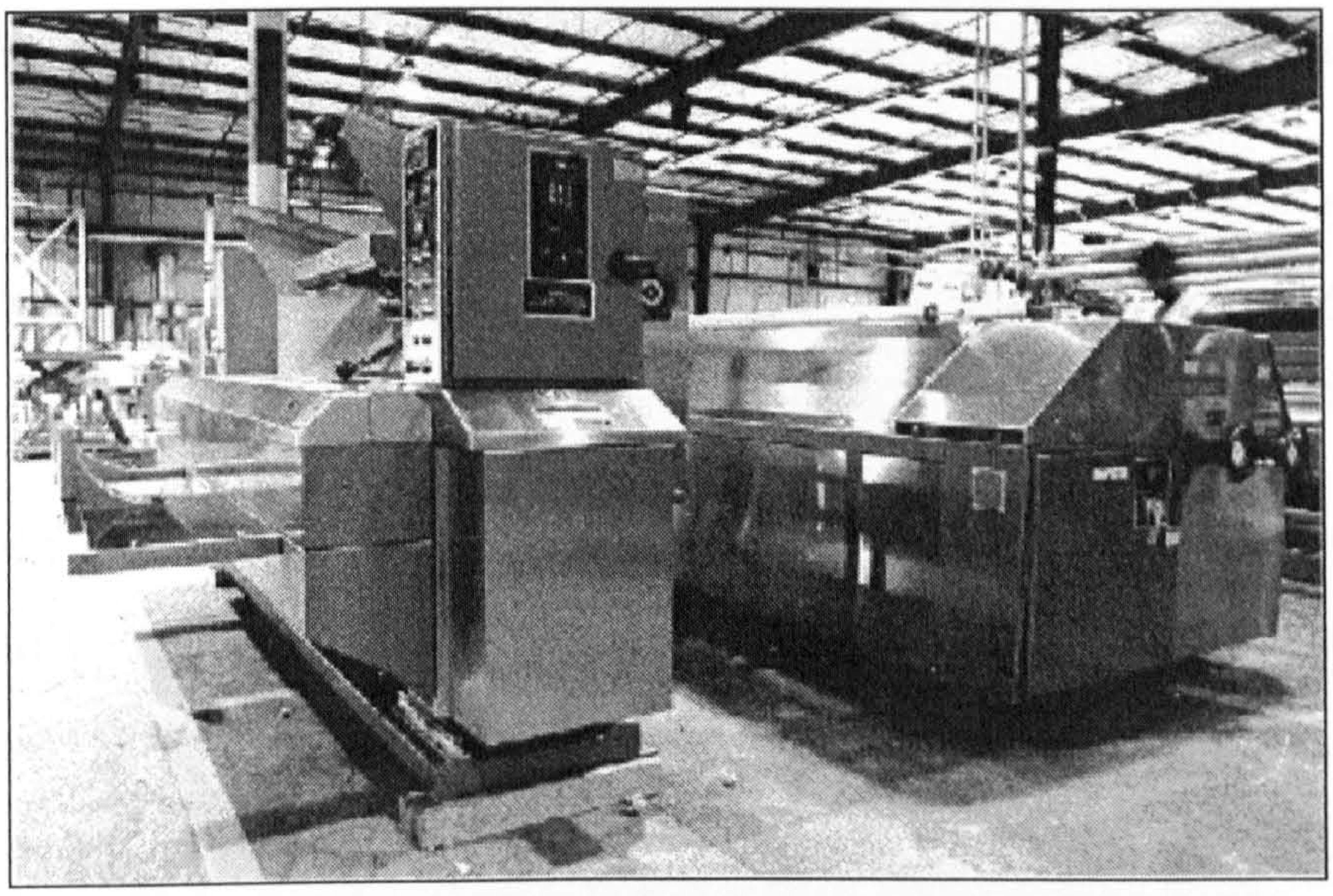


Figure 8.4: A Compactor machine with a new liquid heating and cooling system for preshrinking fabric.

Capital expenditure in 2000 was reduced to $1.5 million in Europe, excluding development projects, and was expended mainly on a single project to overhaul and refurbish equipment in the Company's dyeing facilities.

In 2001, the Company was still in Chapter 11 and finances for development activities were again severely restricted. In fact only $124,600 was allocated to development projects that year, for the following five projects:

(1.) Dyeing machine control system upgrade and development

(2.) Automatic width control system for finishing machine in dyeing

(3.) Trial of a new type of knitting machine to construct a new type of fabric (known as the "28 gauge" project)

(4.) Automatic calibration development, incorporated into the microprocessor for the laser scanner system, which detects defects in fabric

(5.) Development of an automatic oiling system for knitting machines

Capital expenditure for 2001 was again restricted to just under $1.3 million and only those capital projects deemed critical to maintaining operations were undertaken.

So in the period 1999 to 2001, the activities of the department were strongly impacted by the strategic changes that had occurred within the Company and also by the limited finances available whilst the Company progressed through bankruptcy proceedings in the U.S. The portfolio management methods fell into disuse during this period as only "misision-critical" projects were being undertaken.

In 2002, the situation improved dramatically when the Company emerged from bankruptcy in April under new ownership. The finance allocated for new investment projects in Europe was $5.5 million, with over $4 million of this total being allocated to MTA & development projects. Furthermore, the Company was successful in obtaining government funding of $140,000 to undertake some more radical R&D projects involving industry-university collaboration on the use of laser technology in knitting and the development of new process control and monitoring systems for the dyeing operation.

Examples of some of the technology acquisition projects approved for 2002 are given below:

(1.) The acquisition of three new machines for the Dyeing process (Figure 8.5) at a total cost of $579,000. These machines are relatively new to the marketplace and were approved on condition that the trial phase carried out in May 2002 at the suppliers facility in Germany was successful.

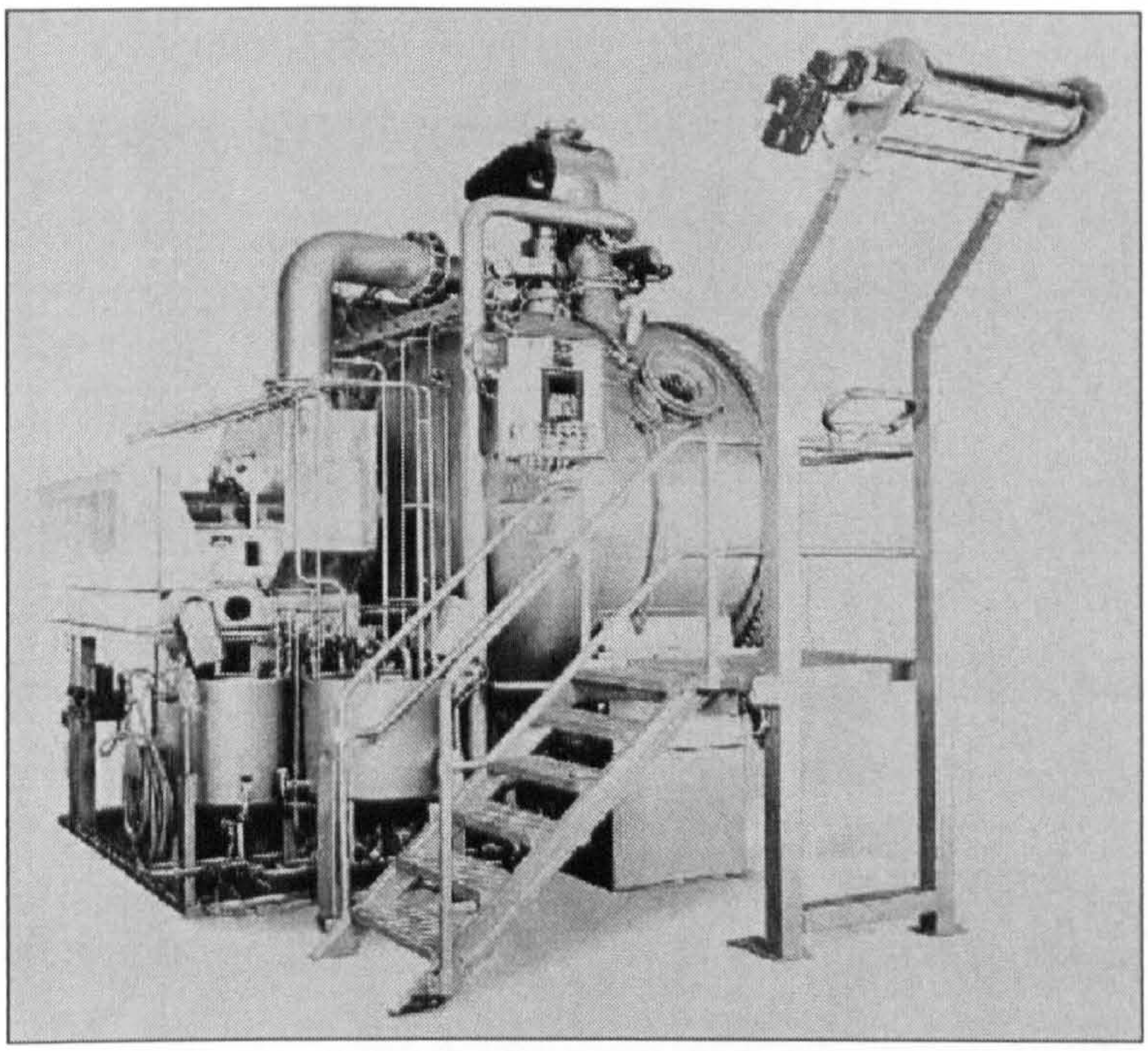


Figure 8.5: One of three new dyeing machines acquired from Thies GMBH.

(2.) The acquisition of a waste recycling process line for reclaiming cotton fibre during the initial stages of yarn production (Figures 8.6 & 8.7). This project has commenced and is due for completion by September 2002, at a cost of $241,000.

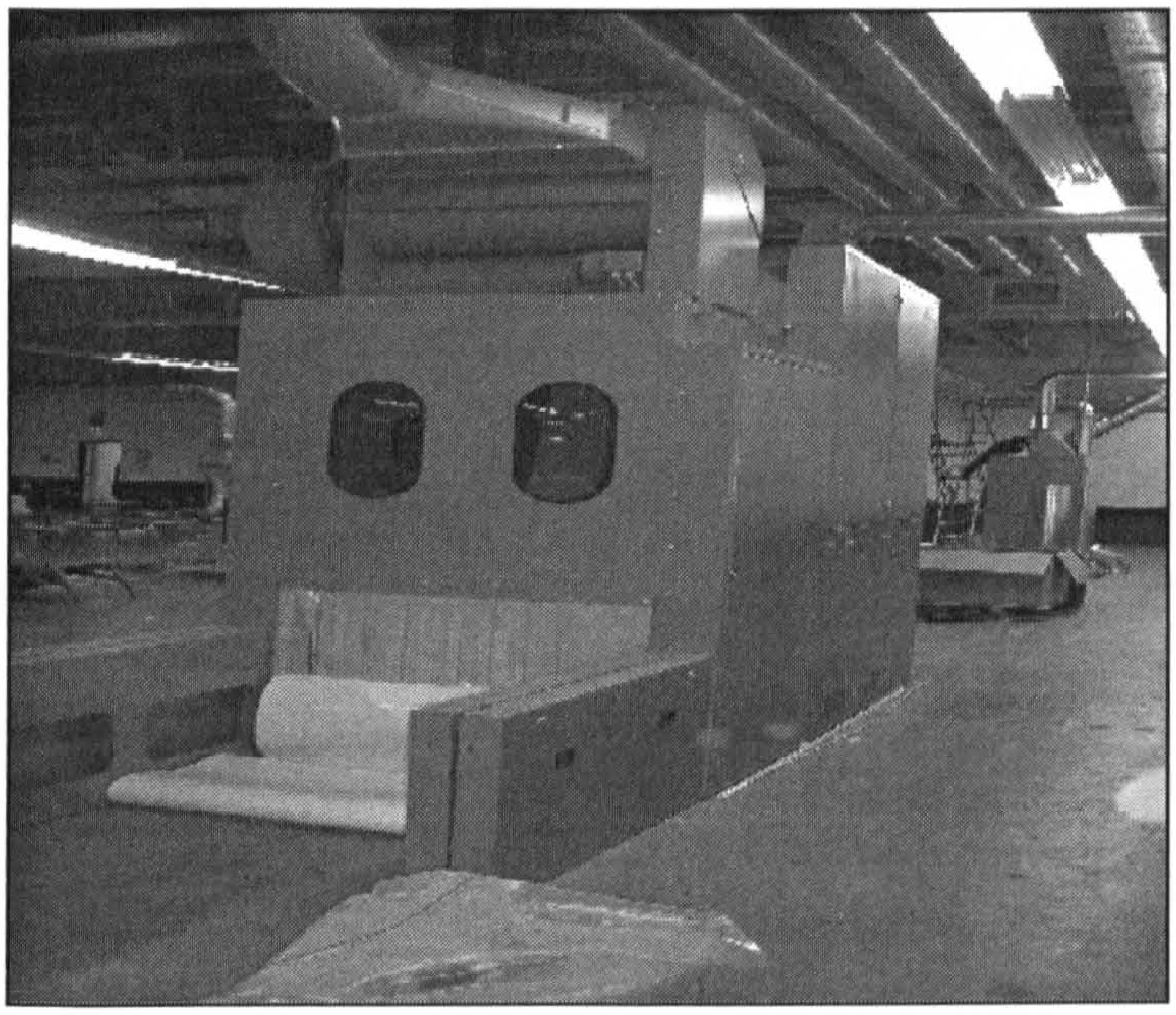


Figure 8.6: A section of the cotton waste recycling process line being installed at the Spinning Mill.

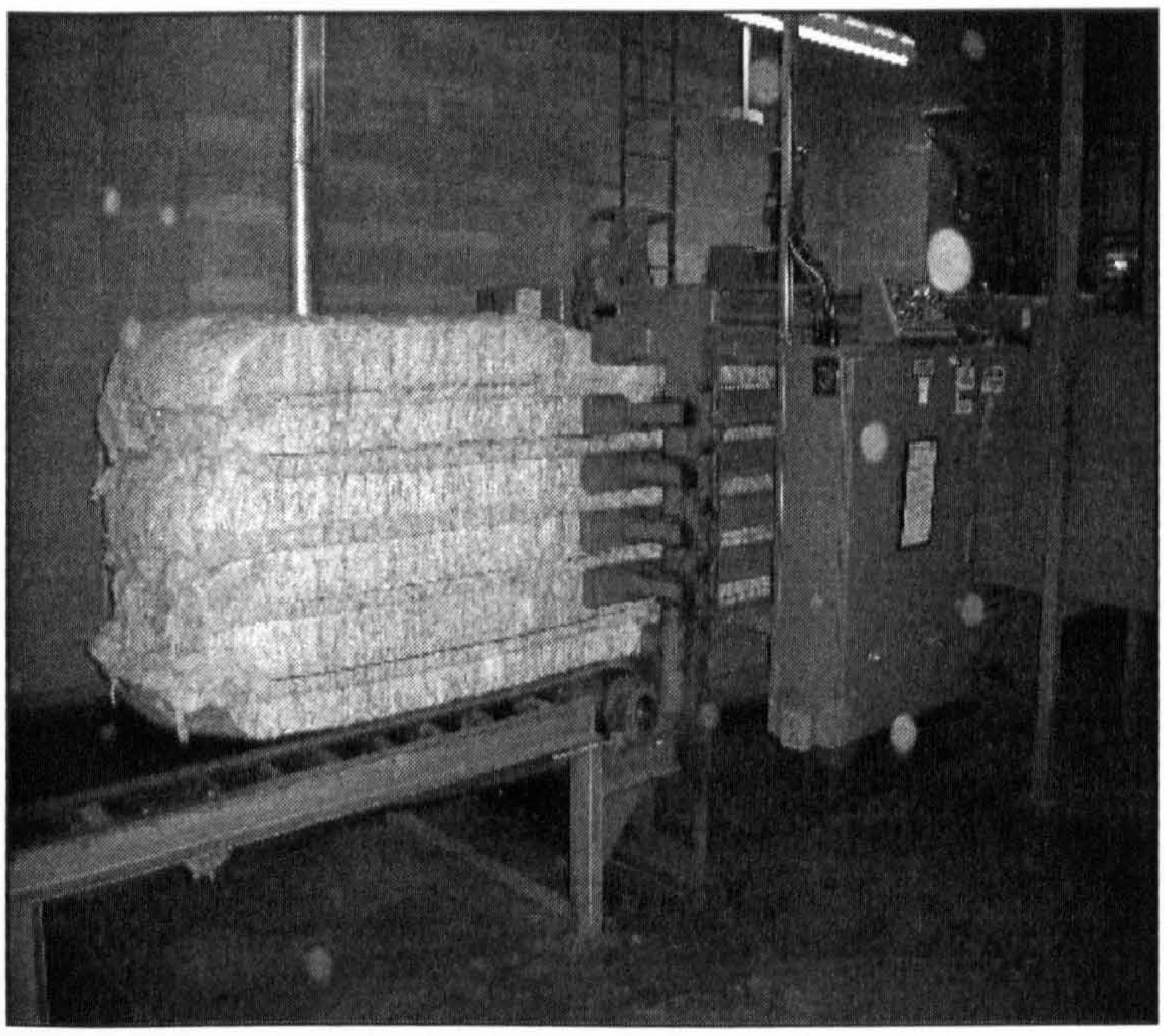


Figure 8.7: A bale of high-grade cotton waste reclaimed from the yarn manufacturing process.

(3.) An on-line control and monitoring system, which ensures the correct fabric density is attained at the final process in dyeing, known as compaction. The finances assigned to the project totalled $275,000. The prototype version of the compaction control system is shown in figure 8.8 and the image of the fabric captured by a camera for computer analysis is shown in figure 8.9.

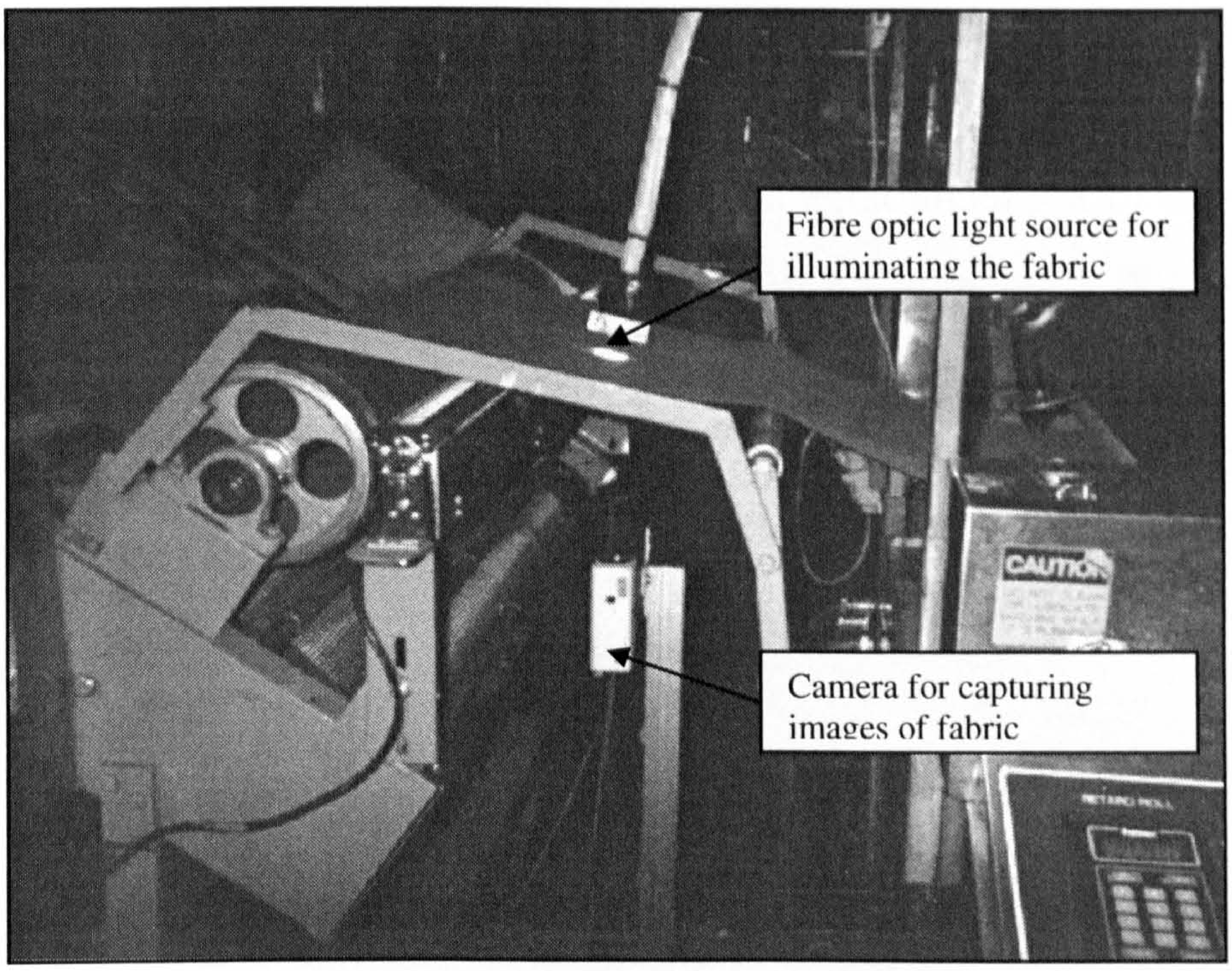


Figure 8.8: Compaction control system for ensuring the correct density of fabric is attained.

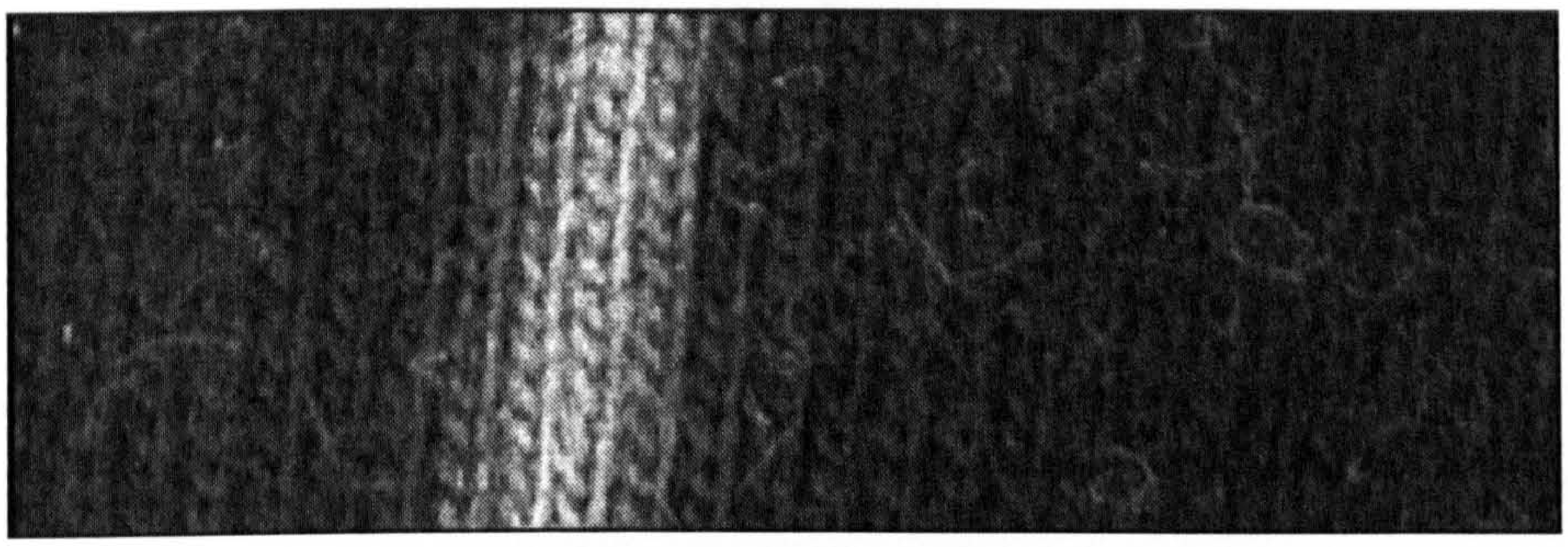


Figure 8.9: Image of fabric captured by the camera for processing by Computer.

The 2002 project selection cycle saw the reintroduction of the portfolio management techniques adapted during the period 1996 to 1998. They were applied in a limited way because up until emergence from bankruptcy was complete in April 2002, there was a lack of clarity about the future strategic direction of the Company in Europe in relation to MTA activities. This made it particularly difficult to apply EMB as a key variable, Strategic Importance (SI) of each proposed project, was unclear. However, after April 2002, the Senior Vice President of Manufacturing was able to confirm the Company's intent to re-establish its commitment to significant investment in manufacturing technology acquisition projects, and he secured the $4 million of funding to do so. The strategic direction became much clearer. Manufacturing could again look forward to a period of technology development.

A new MTA review panel was established in April 2002 to discuss and select the projects, and was made up of the following people:

- Joe Mullan, Senior Vice President of Manufacturing, Europe
- Kevin Conaghan, Chief Financial Officer, Europe
- Catriona Kelly, Technical Services & MTD Manager
- Michael Mallon, Manufacturing Director, Textiles
- Liam Tourish, Manufacturing Director, Apparel & Sourcing

The Company agreed that in planning for 2003 projects, all previously developed portfolio management techniques, including bubble diagrams and EMB, would be used. This process has commenced as part of the 2003 budget planning cycle.

8.5 The Impact of Corporate Strategy on Capital Expenditure

Since its inception in Ireland in 1994, the MTD group was also responsible for the acquisition of all manufacturing technology for the European operations. Once new technology had gone through the testing phase, the MTD group was responsible for the deployment of the technology in manufacturing through Replication. They had the primary responsibility for capital expenditure on manufacturing equipment. As was the case with development projects, the amount of finance available for capital expenditure and technology replication also varied over the research period. The Capital Expenditure during the period 1993 to 2001 is shown in Figure 8.10.

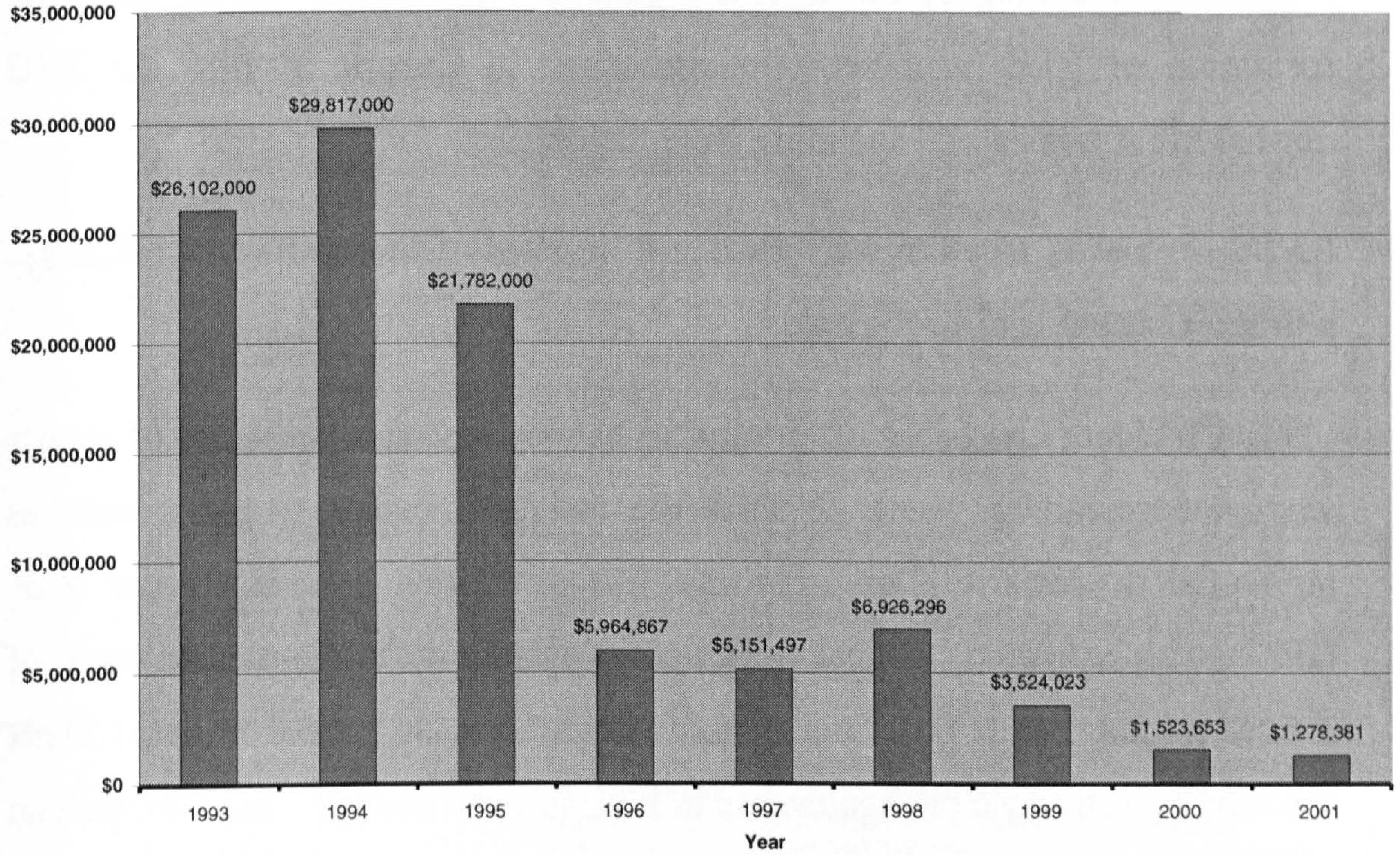


Figure 8.10: Capital Expenditure in Fruit of the Loom Europe during the period 1993 to 2001.

The period 1993 to 1995 was typified by significant investment in manufacturing facilities and technology i.e. building new factories. Both fabric and sewing plants were being expanded to meet increased manufacturing capacity requirements driven by sales growth, and the necessary finance was being made available from the U.S. Parent Company. However, from the period 1996 through to 2001, capital expenditure was restricted as the overall business performance in both Europe and the U.S. went into decline. During 2000 and 2001, when the Company was in Chapter 11, only projects that were termed "mission critical" or "absolutely essential" to maintain operations were progressed, resulting in the lowest period of capital expenditure since the formation of FTL manufacturing operations in Europe in 1987. In 2002 normal MTA and capital spending were restored.

8.6 Summary of Key Organisation and Strategic Change Events (SCE's) using a Critical Incident Chart

Critical Incident charts are often used to display a process or series of events when the researcher wants to limit the listing of events to those seen as influential or decisive. This approach was developed by Stiegelbauer *et al.* (1982), who extracted "critical incidents" occurring during implementation of a new language arts programme at a school site. A critical incident chart showing key strategic change events in FTL in both the U.S. and Europe can be seen in Table 8.2.

Year	U.S. Organisation	U.S. SCE	European Organisation	European SCE
1994	Chairman- W.Farley President-J.Holland	• FTL acquire 4 companies for $350 million, financed by increased debt	President-J.Gariepy MD-W.McCarter CFO-L.Marbury	• Two new sewing plants opened in Ireland • R&D dept set up
1995	No major change in management	• Offshore Sewing Move starts; target of 30% moved by year end • 13 manufacturing facilities closed	**IN** President-B.Hansen CFO-H.Rauzi **OUT** President-J.Gariepy	• Distribution Centre opened in Germany
1996	**IN** CEO - W.Farley COO -R.Lappin CFO - L.Switzer CIO- B.Heise SVP Mft – S.Vinson **OUT** President & COO- J.Holland	• Marketing-led strategy implemented • Offshore sewing move continues; target of 58% by year end	**IN** IT Director-P.DeMedts COO-H.Rauzi	• Closure of some sewing plants in Ireland announced • New IT Centre opened in Belgium
1997	**IN** SVP Mft- G.Wood **OUT** SVP Mft – S.Vinson	• Offshore sewing move continues; target 70% by year end • Net Earnings Loss of $488 million	**IN** VP Mft-A.McCarter Dir Mft-J.Mullan Dir Mft-K.Rutherford **OUT** MD-W.McCarter Dir Finance-S.McEleney Dir Sales-J.McCarter	• Net Earnings loss of $24 million
1998	**IN** CEO, COO-W.Farley CFO- W.Newton EVP Ops- E.Turner SVP Mft- E.Fuller Pres Sales- V.Tyra Pres Sales- J.Salisbury **OUT** COO- R.Lappin CFO- L.Switzer SVP Sales- G.Raley SVP Mft- G.Wood	• Use of Contract Manufacturers extended • Offshore sewing at 95% by year end. • Set up Cayman Islands holding Company • Continue marketing led strategy • Closed down U.S. R&D facility	**IN** President-F.Sulzberger VP Sales-C.Flauraud VP Sales-R.Gaebke VP Logistics-M.Ehmes VP Mft-J.Mullan VP HR-C.Hochstrasser Dir Technical- M.Mallon **OUT** President-B.Hansen VP Mft-A.McCarter COO-H.Rauzi VP Sales-R.Barnes Logistics Dir- C.Donaghey Dir QA-M.Cullen	• Major change in Retail business strategy • Three sewing plants in Ireland closed with the loss of 700 jobs • Net Earnings of $29 million
1999	**IN** CEO-D.Bookshester EVP Ops-J.Holland EVP Mft-R.Medlin VP Distribution- J.Matthews VP HR-L.Thompson EVP Sales-J.Wigodsky **OUT** CEO,COO-W.Farley EVP Ops-E.Turner SVP Mft-E.Fuller Pres Sales-V.Tyra Pres Sales-J.Salisbury	• Net Earnings loss of $572 million • Company files for Chapter 11 Bankruptcy protection in December • Further plant shutdowns	**IN** President-B.Hansen VP Finanace –D.Mulder Dir Planning- M.Mallon Dir Distribution – M.Ehmes Dir Sourcing – H.Heppe VP Sales- R.Blankenship Dir HR – E.McIlroy **OUT** President- F.Sulberger VP Sales-C.Flauraud VP Sales-R.Gaebke VP HR-C.Hochstrasser	• Continue to outsource Retail product • Cancel F.Sulzberger's Retail strategy • Net Earnings loss of $55 million on Turnover of $213 million • MTD/R&D Dept staffing reduced • Spending Freeze on MTA
2000	No significant changes to senior management team in U.S. although former president J.Holland appointed COO	• Joint Plan of Reorganisation filed with U.S. bankruptcy court • FTL seeks investors/new owners • Disposal of non-	**IN** SVP Finance- L.Marbury SVP Mft-j.Mullan SVP Sales- A.Kirby VP Sales-S.Consiglio Dir Mft-M.Mallon Dir Apparel-L.Tourish **OUT**	• Vision to grow European business stated by U.S. COO • Net Sales decreased to $174 million, with an earnings loss

		core business assets.	Exec VP Finance-D.Mulder VP Sales-R.Blankenship	of $2.6 million • Two more sew plants closed in Ireland
2001	No significant changes to senior management team in the U.S.	• Investor options narrowed – Berkshire Hathaway emerge as final takeover favourites • Net Sales $1,342 million	**IN** VP Sales-S.Nannini Dir Sourcing-L.Tourish **OUT** Dir Sourcing-H.Heppe	• Review of Sales organisation • Net Sales of $176 million & Net Eamings of $2.6 million • Announcement to consolidate textile plants
2002	**IN** Warren Buffet – FTL main board Chairman and CEO – J.Holland **OUT** CEO – D.Bookshester EVP Sales – J.Wigodsky	• Berkshire Hathaway acquire FTL in April for $835 million, ending bankruptcy period	**IN** CEO – L.Marbury CFO – K.Conaghan	• Investment programme for MTA re-established - $4 million

Table 8.2: Critical Incident Chart showing key changes in Management composition & Strategy 1994- 2002.

8.7 Summary of Strategic Change Events in relation to the Research Project

The many changes in strategy within the Company coincided with the research period, the research work being undertaken on a part-time basis over almost seven years. It was inevitable that changes would be observed. Table 8.3 summarises some of the key strategic change events in relation to the components of the research work carried out in each of the years.

EVENT	1994	1995	1996	1997	1998	1999	2000	2001	2002
Key Strategic Change Event - U.S.	x4 companies acquired for $350 million	Offshore sewing starts - 30% by Dec	Marketing-led strategy	Offshore sewing now at 70%	R&D Centre closed Offshore sewing at 95%	FTL files for Chapter 11 bankruptcy	Company Reorganization plan	Company for Sale	Berkshire Hathaway acquire FTL
Key Strategic Change Event - Europe & Ireland	High levels of investment in Manufacturing	2 new sewing plants in Ireland	Offshore sewing announced only 2 sew plants closed	Offshore move continues	Marketing-led strategy implemented New HQ Switzerland close 3 sew plants	Cancel marketing-led strategy New HQ closed	2 more sew plants closed Offshore sewing at 100%	Consolidation of textile plants announced	
MTA activities - Ireland	R&D Dept established	R&D personnel recruited + projects	Project Review Panel set up Portfolio management	Portfolio management	EMB Project selection Sewing automation projects cancelled	MTD staff cuts MTA spending freeze Survival issue	Finance limited strategy "fuzzy"	Finance limited	New MTA investment
MTA project budget	NA	NA	$1.5 million	$1.2 million	$1.4 million	$100,000	$230,000	$124,300	$4 million
Capital Expenditure - Europe	$29.8 million	$21.8 million	$6.0 million	$5.2 million	$6.9 million	$3.5 million	$1.5 million	$1.3 million	$5.5 million
This Research		Literature Review & Research Plan	Success Factors & Measure MTA cycle 1	MTA cycle 2	Auto Loader Case Study MTA cycle 3	Auto Loader Case Study	SCE	SCE Write-up	Write-up
Researcher's Job	R&D Manager	R&D Manager	Group Technical Manager	Group Technical Manager	Technical Director	Director of Planning Europe	Manufacturing Director - Textiles	Manufacturing Director - Textiles	Manufacturing Director - Textiles

Table 8.3: Summary of key events during the research period.

8.8 Discussion

The retrospective analysis of events during the research period clearly indicates that strategic change events had a significant impact on the activities being undertaken by the Company. The relatively frequent changes in executives and leadership led in turn to changes in business strategy as new senior managers sought to bring their own ideas to the fore. Middle management, such as functional or departmental managers, further down the organization hierarchy had no choice but to follow these changes in strategic direction, with little chance of influencing them.

Corporate strategy was observed to have changed a short time after each significant change in U.S. management had taken place. Similarly, each change in management in Europe was followed by a change in business strategy. Most changes of strategic direction embarked upon by the U.S. Parent usually were implemented at a later stage by the European subsidiary too. For example, the strategy to relocate sewing to lower-cost countries. The change in sewing strategy was announced in the U.S. in 1995 and in Europe some twelve months later. In many instances, significant periods of time elapsed before U.S. Company strategy was officially transferred to Europe.

Another observation was that the European Company's strategy could exist for a number of years unchallenged, but could be changed almost overnight by a directive from senior management in the U.S. Parent. Nowhere was this more pertinent than in the sewing automation strategy being pursued by the factories in Ireland. The operations in Ireland had invested heavily in automated sewing from 1990 through to 1998 based on the stated strategy. It changed literally overnight during a visit to Ireland by the Chairman and his U.S. management in September 1998, when a directive was given to change the manufacturing process to a cell-based system and close the remaining sewing plants in Ireland. This SCE meant the cancellation of all sewing automation projects.

The rate of change in senior management positions was high, leading to a less than stable operating environment. The average tenure of a function head, for example, VP of manufacturing in the U.S., was around 18 months. The frequency of change probably had as much to do with the Chairman's ego and temperament than it had with the competencies of the individuals coming and going from the organisation. The instability in the management hierarchy resulted in regular changes in strategic direction, leaving a "fuzzy" strategy for middle managers to work to. Typical comments by middle managers during these periods of change included "I wonder who'll be next to go?" and "where are we heading now?"

The appointment of Felix Sulzberger as European President in 1998 had a major impact on MTA activities in Europe. He reduced the manning levels in the Manufacturing Technology Development department, curtailing their ability to carry out as many projects as they had done before. The department's budget was significantly reduced, as was the amount of capital available for investing in new manufacturing technology. These strategic changes were imposed by the European President, with the MTD manager having little choice but to execute the directive given to her. This is yet another example of how a single senior executive can have a major influence on the strategic direction of an organisation. It took until 2002 for the department to recover from this SCE, when the strategy to invest in manufacturing technology was again committed to by the Company, and finance was made available to do so.

The use of the MTA techniques developed from this research and adopted by the Company, including portfolio management and Expected Manufacturing

Benefit, were affected too by strategic change events. The accepted successful application of these techniques for selecting projects up to the 1998 cycle has been previously documented. However, with the restriction on finances, the reduction in manning within the MTD department and the fact that the Company was in bankruptcy from December 1999, there was a pause in the use of the project selection techniques. How could EMB be calculated when one of the core input variables for ranking ordering the projects to be selected was Strategic Importance (SI)? The strategy was at best unclear, was continually changing and was not understood by those middle managers who were expected to execute the strategy within the factories. Also, only those projects viewed as being absolutely essential to maintaining manufacturing operations were undertaken. These were times of exceptional uncertainty, when the Company's very survival was under threat. The appropriateness of the MTA selection methods in such circumstances was challenged and the senior manufacturing management in Ireland decided to put their use "on-hold" until some clearer strategic direction had emerged. The uncertainty that prevailed during this period was not unique to MTA activities. Other functional areas such as Sales, Marketing, Distribution and Finance all experienced similar uncertainties. The Company's suppliers were concerned about the ability of the Company to pay for their products and services and reassurances had to be given by FTL's bankers. Customers too were questioning the Company's ability to supply them with product given a perceived risk due to the bankruptcy proceedings.

The strategy of the MTD unit from 1998 to 2001 was one of survival. Now that Fruit of the Loom has emerged from bankruptcy under new ownership, the outlook is more positive and the reintroduction of the MTA methods developed from this research work is in progress. The strategic direction given by those managing the business has been to return to what is regarded by senior management as the Company's primary competitive strength, that of high volume, low cost manufacturing, offering value for money products. A fundamental requisite for this is continuous investment in appropriate cost effective manufacturing technology.

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Chapter 9

Research Results & Conclusions.

9.0 Introduction

This concluding chapter summarises the results of the research, examines the findings and discusses their application to Manufacturing Technology Acquisition. The limitations of the research work and areas for further investigation are also discussed.

The components of the research work, including success factors and measures, portfolio management techniques adapted from the field of new product development, and strategic considerations, are brought together in a proposed new model for acquiring manufacturing technology.

9.1 Summary of the Results

The results of each of the phases of the research were discussed in detail in the relevant chapters. The overall results of the complete study of MTA are summarised and reviewed in this chapter.

9.1.1. Summary of the Literature Review

An extensive review of the literature in Technology Management and associated fields was carried out at the outset of the research project and was continued throughout the entire research period through subscription to all the relevant journals. The following points summarise the key findings from the literature review:

- While much has been written on Technology Management and on R&D Management for new product development, little has been written in the field of Manufacturing Technology Acquisition. Any work that has been published has tended to focus on a single aspect of this process (for example Tyre (1991) on implementation) or in related fields such as Advanced Manufacturing Technology (AMT) by authors such as Noori and Radford (1990) and Gindy (1998).

- In the field of New Product Development, many models explaining how to successfully undertake this activity are now well accepted and widely applied, the most famous of these being Cooper's work on the Stage-Gate process (1993) and on Portfolio Management (1998). Cooper's methods for NPD are used in hundreds of companies worldwide. In stark contrast, in the field of MTA no similar established methods exist, let alone are applied universally by companies.

- The literature survey supported the case that many companies fail in some of their attempts to successfully acquire manufacturing technology ((Thurow (1987), Tyre (1991), and Chung (1996)).

- In the field of NPD/R&D Management, a review of the techniques and tools (Brady, 1995) highlights academic claims that most classical R&D project selection models have been virtually ignored by industry (Schmidt and Freeland, 1992) and that quantitative models have had no apparent impact on industrial practice (Steele, 1988). Cooper's methods are the one exception to this.

Thus, it was concluded that knowledge concerning selecting the right MTA projects in a company and successfully implementing them is in an embryonic phase.

9.1.2 Summary of Success Factors & Measures in MTA

Manufacturing managers were interviewed to determine what factors might contribute to success or failure when acquiring manufacturing technology. Whilst previous work in the fields of NPD and R&D had identified many factors which can contribute to success or failure, it was not known whether the list of factors would be similar for MTA. It also became apparent that a determination of what was meant by "success" was necessary as many interviewees had stated that they had not previously considered what was meant by success at a single project level or indeed how to measure it.

Key findings in relation to the success factors and measures were:

- Seventy-five factors which can contribute to success or failure when acquiring manufacturing technology were determined.[1]
- Of the seventy-five factors, 51% were unique to individual projects, which is similar to the findings in the literature on NPD and R&D (Balachandra and Friar, 1997), where 50% of the factors were found to be specific to a single study.
- Of the seventy-two factors compiled by Balachandra and Friar, only twenty-four were found in the survey on MTA.
- Of the 28 occurrences of factors in the "Technical" category cited as influencing the outcome of a project, 70% of the time they were cited as contributing to the failure of a project as opposed to its success.

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[1] One additional factor (training of personnel on equipement) was discovered later in the single case study in chapter seven.

- There was an average of 8.7 factors stated as contributing to success or failure in each project.

- Thirty-eight measures of success were established from the interviews, with an average of 5.8 measures per project.

- 47% of the measures were unique to a specific project.

- Production output, quality and downtime were the three most frequently occurring success measures, and were used to measure project outcomes in 50% of the projects.

- Manufacturing performance measures (e.g. downtime, quality, efficiency, capacity, etc) accounted for 29% of all measures used.

- Economic and financial measures (payback, ROI, profit, savings, etc) accounted for a further 18% of the measures used and were stated in 65% of the interviews.

The factors and measures were developed into a "checklist" for use when acquiring manufacturing technology.

9.1.3 Summary of the Project Selection Methods

Chapter five consisted of a review of the methods used to select new product development projects, including portfolio management techniques. Portfolio management techniques are now well accepted in NPD and their use is relatively widespread. However, there is no body of evidence that demonstrates their use or applicability to in the field of MTA. Here, the methods used for project selection and technology investment decisions remain dominated by the simple financial appraisal techniques of Payback, Return on Investment and

Discounted Cashflow (Lowe, 1995). The interview results reported in chapter four further supported the widespread use of financial measures as the primary methods in use today when selecting manufacturing technology projects.

However, these methods had proved to be of limited value for selecting manufacturing projects in Fruit of the Loom. Failures in MTA were still occurring and hence this research project was undertaken with the objective of developing improved selection methods. Both the literature review and the interviews in chapter four supported the Company's experiences that failed projects were quite common.

At around the same time as the research was starting, Third Generation R&D Management (Roussel *et al*, 1991) and Cooper's groundbreaking work on NPD management methods were coming to the fore in both academic thinking and industrial management practice. The challenges facing companies carrying out MTA were viewed as being similar to those of NPD in that the company is trying to maximise the value of the portfolio of projects, ensure strategic fit and balance the potential rewards with the associated risks. It was therefore logical to assess the relevance of the latest techniques from the disciplines of R&D and NPD management to that of MTA.

R&D and NPD project selection methods were adopted and modified over three annual cycles of selecting MTA projects within Fruit of the Loom, Europe, eventually leading to a new method for selecting projects being implemented as policy within the Company as a direct result of this research.

The elements of NPD and R&D management methods adopted and implemented over the period 1996 to 1998 included:

- Portfolio Management methods, including bubble diagrams illustrating risk versus reward for the portfolio of projects under review

- An assessment of the Strategic Importance (SI) of each project in the proposed portfolio, using a scoring matrix containing the elements congruence, impact, proprietary position, durability and application potential

- An assessment of the Probability of Technical Success (P_{TS}) of each project, again using a scoring matrix to assess relevant factors including technical gap, program complexity, technology skill base, technical resources and the maturity of the technology

- The development of the concept of Expected Manufacturing Benefit (EMB) for each project under review. This calculation took into account SI and P_{TS} as outlined above, and also a calculation of the Net Present Value (NPV) of the project, the Development Costs (D) and the Capital Costs (C_A) to apply the project in the manufacturing plants. It is given by the formula:

$$EMB = (NPV*SI-C_A)*P_{TS} - D$$

- The EMB is then divided by development or acquisition costs to yield a ratio EMB/ D, which in effect expresses benefits against development costs for a one-off application. This yields a rank-ordered list of projects, which maximises the value of the portfolio to the Company. The ranking offers the potential to prioritise projects up to the level of the MTA budget in any given selection period, which is extremely useful in circumstances where there are likely to be more projects seeking funding than there is funding available.

- In the third annual cycle of testing out this method in a live manufacturing environment, another factor was added to the project selection process, that of Human Resource Availability (HRA). Each project was assessed and given a rating (A, B or C) as to whether sufficient resources were available to undertake the project. In some projects, even if the strategic importance score was high or the EMB was significant, the resources may not have been available to undertake the projects, and a 'C' rating would have been applied.

- The concept of Replication emerged as an important consideration during the three annual project selection cycles. The greater the potential of a project to be applied widely throughout manufacturing, the greater the likely financial return to the Company and the more attractive the project was likely to be. This I have called the "Replication Benefit". Prior to the Company sponsoring this research project, the policy was to commit to the acquisition of a number of machines simultaneously to avail of multiple purchase discounts. Through the research a new approach was established which involved piloting a one-off application only, prior to replicating throughout manufacturing. This helped to mitigate the risk of multiple failures after acquisition.

- Another key finding concerned the involvement of senior management in the project selection process. Previously they had been involved in the process using simple tools and their experience. When they were offered a structured methodology, they willingly adopted it even though this meant hard work and a learning process. The success of the new methods led to the process being formally adopted as policy for MTA in Fruit of the Loom, Europe.

The view of those senior managers with overall responsibility for manufacturing was that the improved portfolio selection methods coupled with the more formal review process delivered a significantly superior project selection process than had existed previously. Portfolio management techniques enabled optimal manufacturing investment decisions to be made and the right projects to be chosen.

9.1.4 Summary of the Study of MTA at a Single Project Level

It was decided to follow a single MTA project through from the concept generation stage all the way through to the finish, to examine how realistic the research findings to date were at the single project level. This single case study involved the acceptance trials of a new machine to automate the loading of Tee shirt sleeves into another automated sewing machine.

The key findings from this phase of the research were as follows:

- The case study gave strong support for the Factors list, with 53 of the original 75 factors being present in this project. The high number of factors occurring in a single case was a surprise and indicates that this case at least was highly complex. The average number of factors per project stated in both the literature and the original survey work to generate the factors list (chapter four) was significantly lower than in this project.

- The findings lent support to the "completeness" of the original list of factors in that only one new factor emerged, that of "training of personnel" in the use of the machine.

- The case also gave strong support to the measures list, with 23 of the 38 measures being present and used being to evaluate the outcome of the project.

- The portfolio approach, which is based on the assumption that you cannot fully predict success and must therefore run a collection of projects in a staged manner, balancing risk and potential reward, was supported by the events of this single case. The project was originally thought to be of high risk, later thought to be fairly certain, and finally failed comprehensively.

- The case study supported the Replication concept, through the process of undertaking a comprehensive and thorough trial of a single unit before committing to large-scale investment in a technology that would have failed.

Alongside the support for the research work on portfolio management and factors and measures, three new concepts for consideration emerged from this single case study:

(1.) Multiple causes of failure. The Loader project could have failed on any one of a number of measures, caused by technical failure factors. If it had not failed firstly for technical reasons, it would have failed later due to strategic change factors, including the decision to relocate all sewing to low-cost labour countries. In effect, there were multiple causes of failure.

(2.) Uncertainty of Result. There was a difficulty of predicting the project outcome. All of the project team was confident of success at the early stages, once the project had started. However, the evidence was there of danger areas especially from the Supplier interviews, but among the large number of considerations significant indicators were missed. Despite an extensive technical assessment of the machine prior to shipping to the factory, technical failure still occurred.

(3.) Corporate Environment Factors. Even though there was evidence of ongoing corporate debates on strategy in relation to the sewing operations, no alarm was raised that they might pose a threat to the project. The strategy to invest in highly automated sewing technology had been in existence for a number of years, but it changed literally overnight during this project. Thus, even if a strategic direction is clear at the project selection stage, it can still change very quickly and impact on a project. This strategic change rendered all previous sewing automation projects void and ultimately all the technology acquired in previous years became obsolete. Thus Strategic Change Events (SCE's) can have a significant impact on MTA activities. It is important to note that this project was selected before EMB (and thus Strategic Importance) was formally adopted by the Company. However, this project would probably have scored high on Strategic Importance at the time of selection.

This single case lent support to the findings of the earlier phases of the research work on portfolio management and success factors and measures. It also vividly illustrated the overriding importance of strategy as a major consideration in selecting and undertaking MTA projects, yet where is strategy considered in the traditional and most widely used MTA project selection methods of Payback, DCF and Return on Investment?

9.1.5 Summary of Strategy in MTA

Strategic changes during the research period occurred on a regular basis and significantly impacted MTA activities in the late 1990's. It was decided that these Strategic Change Events (SCE's) were a real research consideration and needed to be examined as part of the scope of the research work.

Key findings from this retrospective examination of the impact of Strategic Change Events included:

- Corporate strategy was modified shortly after each change in senior management took place in the U.S. The same happened in Europe

- Changes in senior management in both the U.S. and Europe occurred frequently (see Table 8.2, chapter 8)

- A particular business strategy can be in place for a number of years, but when the change occurs it can happen almost overnight and can have a significant immediate impact. In the case of MTA activities in the Company, this involved the immediate cancellation of all automation projects in the sewing plants

- In these times of strategic change, middle managers were charged with executing the strategic changes initiated by the parent Company. For example, the Manufacturing Technology Development Manager had to decide which personnel in the department were to be made redundant when the downsizing of the function occurred following a directive from the European President

- Spending on MTA activities and capital projects was very much curtailed in times of major upheaval and restructuring. It took a number of years to recover from this period of minimal financial support for MTA

- The board members and the CEO in particular had an overwhelming impact on the strategic direction of the Company in the late 1990's and on its performance which resulted ultimately in bankruptcy. Conversely, the new CEO, John Holland, was responsible for turning the Company around and for its acquisition by Berkshire Hathaway, Inc.

The relevance of this section of the research to MTA is that it clearly illustrates that corporate strategic events can have an overriding impact on MTA activities. When planning for and executing MTA activities, awareness of strategy and the impact it can have is of critical importance.

9.2 Research Conclusions

Research into how to successfully acquire manufacturing technology has been limited to date. This is particularly clear from the literature review, which provided little or no guidance on how to successfully undertake this activity. In contrast, the fields of NPD and R&D Management have been extensively researched with a wide body of knowledge available on these subjects. Furthermore, this knowledge has been developed into practical tools and techniques of real value to the practitioner, and has been adopted by many companies on a global basis. The same cannot be said in relation to methodologies for successfully carrying out MTA. However, as a result of this research, a new method for MTA has been developed which has proven to be of real practical value to those responsible for undertaking MTA in the sponsoring Company. As a result of the study, knowledge on acquiring manufacturing technology has increased.

9.3 Importance of the Research

The results of the research hold interest for both academics and practitioners.

For academics, it has been shown that some of the very thoroughly researched techniques from the NPD field can be adapted and applied to the field of MTA with a comparatively limited amount of work, and with a high degree of success. The use of a theoretically based study (literature review) and empirical investigation (interviews and content analysis) to establish a comprehensive list of success factors and measures, and the application of established methods adopted from the new product development field (portfolio management) provided a robust examination of such techniques.

For practitioners, the research gives an insight into the experiences of other companies when acquiring manufacturing technology. It offers a model to guide them through the process of selecting the appropriate portfolio of projects using novel project ranking methods (EMB & Portfolio) as opposed to the more common financial techniques (DCF, NPV, IRR). Alongside this it offers a comprehensive list of factors for consideration when acquiring manufacturing equipment which can contribute to success and failure at a single project level. Individual project outcomes can be measured using the extensive list of success measures determined from the research. Finally, the overriding importance of strategy as a critical input is highlighted based on the findings in chapters seven and eight. These methods should have considerable economic benefit through better selection of projects and an improved management of their risks.

9.4 Contribution of the Research

The research offers new knowledge about MTA, a new theory of how it should be managed and a model of the process. These comprise the following components:

(1.) A demonstration of the importance of managing MTA as a high-risk activity.

(2.) A comprehensive list of new factors, which can contribute to success or failure when undertaking MTA projects. The final list of factors contained 76 success factors.

(3.) A comprehensive list of measures, 38 in all, which can be used to measure the outcome of MTA projects.

(4.) The Expected Manufacturing Benefit formula for ranking potential MTA projects to assist in the selection of a portfolio of projects to be funded.

(5.) The Risk/ Reward Bubble diagram adapted to MTA, to further assist in the portfolio selection process.

(6.) The Replication concept and ways to incorporate it in the MTA process.

(7.) The importance of being aware of the variability of Corporate Strategy when carrying out MTA projects.

These components were brought together in a tested model for acquiring manufacturing technology. Guidelines for using the model are given. The model is presented in the following section.

9.5 A New Model for Manufacturing Technology Acquisition

It was felt that the best method of bringing the several components of the research together would be through the use of a model for MTA, which incorporated the key findings of the research. This proposed new model is presented in Figure 9.1.

The model begins with the project selection phase. This section brings together the portfolio management techniques adapted from NPD and R&D

management, including the bubble diagram of risk versus reward. The newly developed concept of Expected Manufacturing Benefit is also used during the selection phase. The other components of the model in this part of the MTA process include the project review meetings and an assessment of the likelihood of strategic change events occurring.

The next phase is the project execution stage, which occurs only after the project has been selected. The individual project commences, and during the entire execution period, the project is reassessed against the success factors to ensure that each factor listed is being evaluated for possible impact.

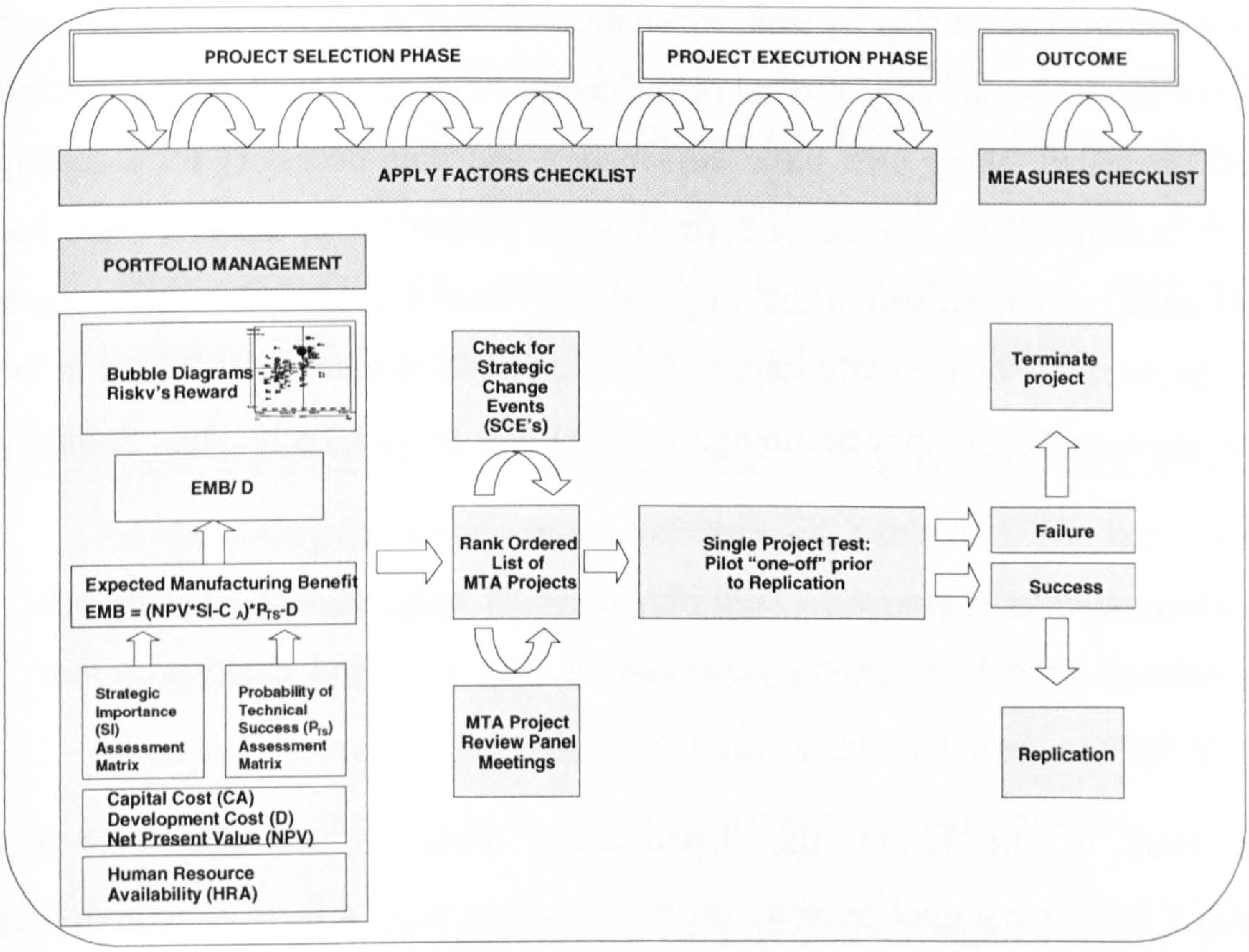

Figure 9.1: A New Model for Manufacturing Technology Acquisition.

During both the project selection and execution phases, the projects are assessed for the presence of each of the success factors and the possible impact they may be having. This is explained further in the following section on how to use the model.

In the final phase, the outcome of the project is assessed using the checklist of measures alongside any quantifiable data that may have been obtained during the piloting of the single project. Finally a decision is taken as to whether the project has succeeded or failed. If successful, Replication across multiple manufacturing units can occur where applicable.

9.5.1 How to use the Model

This section gives a step by step explanation of how to use the model. The use of the model begins only after all of the candidate projects have been compiled and presented, along with basic information and data necessary for assessing their potential. The process of formulating a project list in the first place has not been considered within the scope of this research project. However, much of the literature on the early stages of concept development can be found in the literature on Technology Scanning.[2] Lowe (1995) defines Technology Scanning as:

> *"a systematic approach to keep abreast of all technological developments relevant to a business, the opportunities they offer and the threats they contain."*

In Fruit of the Loom, the departmental managers, technical staff and MTD/ R&D personnel generate project concepts using a formal methodology and the process is coordinated by the Manufacturing Technology Development

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[2] The literature on Technology Scanning is quite extensive. Relevant examples of methods used in this process can be found in Cetron (1969), Twiss (1980) and Betz (1993).

Manager. This process yields an extensive list of projects for consideration, as was illustrated in chapter six.

Upon completion of the generation of the MTA projects list for a given annual cycle, the following steps offer progressive guidelines as to how to use the model in practice:

(1.) Generate a project submission form for each project, containing information similar to the form shown in Appendix G (iii).

(2.) Enter each of the projects under consideration into the Microsoft Excel "EMB" spreadsheet (chapter six, table 6.4) used to calculate the Expected Manufacturing Benefit and to rank order the projects.

(3.) For each project, calculate the Strategic Importance (SI) using the assessment matrix illustrated in chapter six, Table 6.7. The key strategic factors considered to generate the SI value include congruence, impact, proprietary position, durability of the technology and application potential. The SI value is then input to the EMB spreadsheet.

(4.) Next, the Probability of Technical Success (P_{TS}) is established for each project using the scoring matrix (chapter six, Table 6.8). The key factors examined and rated include technical gap, programme complexity, technology skill base, technical resources and technological maturity/lifecycle. The probability value is then entered into the EMB spreadsheet and used as an input variable in the ranking process.

(5.) The Development cost (D) for each project is entered to the EMB spreadsheet. The development cost represents the amount of finance required to develop or acquire a "one-off" application that can be pilot tested, regardless of how the technology is acquired (developed in-house, purchased from machine supplier, collaborative project, licensed, etc).

(6.) At this stage, the capital costs (if any) associated with the project are also established as this is later used to generate an estimate of the total capital expenditure required should the project be replicated in multiple units throughout the manufacturing plants.

(7.) The estimated saving per year is established for each project based on a one-off application. This is later multiplied by the number of possible units and used as the cash inflow line when calculating the Net Present Value (NPV) of the project. The estimated savings for the projects are entered to the spreadsheet.

(8.) The number of units applied is entered to the spreadsheet. This shows the number of units that could be applied in the manufacturing plants through the process of Replication should the pilot project succeed.

(9.) Next, the total cost to apply the technology throughout manufacturing (C_A) is calculated automatically in the EMB spreadsheet (number of units multiplied by the capital cost per unit).

(10.) The estimated savings per year are then calculated automatically by multiplying the number of units by the savings from a "one-off" application.

(11.) The Net Present Value (NPV) of the benefits for each project is calculated on a separate spreadsheet, before being transferred to the NPV section to be used in the EMB calculation.

(12.) The EMB is calculated automatically in the spreadsheet using the following formula given in the MTA model, EMB = $(NPV*SI-C_A)*P_{TS}$ - D.

(13.) Next, a ratio is calculated automatically in the EMB spreadsheet by dividing the EMB by the development cost, D.

(14.) The Human Resource Availability (HRA) is established for each project. This should form part of the original "project submission form" details (Appendix G (iii)). A basic project plan should be developed for each project using Microsoft Project or a similar tool (e.g. Primavera) giving key tasks, scheduled start and finish dates and man-hours required for each resource. From this, it is possible to combine all the projects and resources to see if the projects are feasible or not, as this process will show any resource allocation overloading. The rating of HRA is input to the spreadsheet based on the outcome of this process.

(15.) The projects and their data are then sorted by the EMB/ D ratio being the primary sort key, in descending order, with the higher ratio representing the more attractive project. The secondary sort key used is HRA. Thus, the output is a rank ordered list of projects sorted firstly by EMB/ D and secondly by HRA. The project list has now been prioritised.

(16.) The last column on the spreadsheet contains a cumulative development cost value based on this ranking. A cut-off point for the projects is then established, based on the finances available, during the MTA Panel Review Meeting.

(17.) Next, the bubble diagram of risk versus reward is charted to examine the overall portfolio of projects. This gives a visual overview of the balance of risk and reward associated with the proposed project portfolio.

(18.) A meeting of the MTA Review Panel is convened to review both the project list (ranked) and the bubble diagram. The overall project portfolio is discussed and decisions made about which projects to progress and which to drop off. This normally requires two or three meetings before the final project list is established. A key development at the final stage is to examine if there is any risk to the portfolio or a single project due to any likely strategic change events (SCE's). One possibility would be to invite the Corporate CEO into the MTA Review Panel meeting with a remit to advise on strategic aspects. However, Fruit of the Loom have not as yet matured the MTA process model to this level.

(19.) As part of the Panel Review process, the checklist of factors is used when discussing each project, as many of the factors are applicable when considering which projects to select. For example, factors surrounding the project team should examined, as should factors concerning project objectives (objectives clearly defined and understood?). Also, up to this point the only technical assessment has been in developing the Probability of Technical Success score (risk), but the checklist offers an additional comprehensive list of technical considerations.

(20.) Finally, the project list is approved (up to the allocated MTA budget level and provided the bubble diagram is balanced) and the projects commenced. This ends the annual MTA project selection phase.

(21.) The project execution phase refers to single project level MTA events. Here, the factors list can be used throughout the project lifecycle during the individual project review meetings, to examine if all possible factors for success or failure are being considered. For example, in the early stages of the project, a team would usually be formed to carry out the project and appropriate questions to ask at this stage could be (from the factors checklist):

- Does the project manager have the appropriate skills?
- Does the project manager know the people involved?
- Are cross-functional teams required and available?
- Is the team composition correct?
- Do we have a project champion?

The list of factors can be used on a continuous basis by the project team members to examine if the factors are present during the project execution phase, and what impact they are having. It has been established that 76 factors can contribute to success of failure so they all should be continually assessed during the pilot project execution phase.

(22.) At the end of the MTA project pilot period, a formal assessment of the project takes place with the project team members at the "End of Project Meeting". A decision on whether or not the project has been successful is determined using the pre-selected measures from the empirically derived 38 success measures list. These measures are identified at the outset of the project, and used again at this stage. It is important to ensure that whichever measures are chosen, relevant data is being collected throughout the project lifecycle to ensure that a decision can be made based on a quantitative analysis of the project data. Periodic reviews of the project progress should occur on a regular basis, at least every two weeks and this information reviewed.

(23.) Once the project outcome has been decided and a final project report completed, the MTA Review Panel are informed of the outcome. If the project is successful, the potential for Replication of multiple units of the manufacturing technology across the plants is discussed and a way forward charted. Projected savings and costs are revised to reflect the actual results obtained during the pilot study, as more accurate data is now available. An investment case giving the Replication Benefit of applying multiple units is presented to the MTA Review Panel and plans for deployment of the technology are finalised.

(24.) The MTA process is completed when the Review Panel sign-off on the projects.

This new MTA model along with the 24 step guidelines on using it offers an improved method for carrying out this activity in manufacturing companies. A certain amount of work was required to implement the process, and commitment by senior management was required. It has proved to be comparatively easy to use and has delivered a structured and disciplined approach to the challenge of successfully acquiring manufacturing technology

9.5.2 Discussion of the End of Project Meeting

The "End of Project Meeting" is a critical milestone in the project lifecycle. It is during this meeting that a full project report and associated information is presented and reviewed by the project team. The use of the success measures, which were selected at the outset of the individual project, is central to the decision making process at this point. Typically, the primary quantitative success measures of production output, quality and reliability (machine downtime) will be reviewed against the original targets agreed for the manufacturing equipment. Also, the operating costs and financial benefits of acquiring the technology will be calculated based on the actual data obtained during the trial period. Depending upon the type of project, other measures will be used to assess the overall outcome of the project, for example:

- Is the training time for operators shorter or longer than expected?
- Is the space required to operate the machines more than was anticipated, and what impact will this have on overall plant layout?

It is also possible that whilst some performance measures may have been attained during the trial project, others may not have been achieved. For example, the production and machine reliability targets may have been achieved, but too many defective products were generated. Should we reject the equipment because of this? What if the defect levels were only 0.5% above the target level?

The point here is that although the process of measuring a single project's outcome involves an analysis of quantitative data, the decision on success/ failure is seldom purely "black and white", but instead requires some debate by the team based on their experience, knowledge and maybe even "gut feeling" about the technology. In reality the determination of success or failure of a technology is both objective and subjective; however the measures checklist provides a framework for assisting in the evaluation of project outcomes.

9.6 Limitations of the Research

The research contributed to new knowledge to the field of Manufacturing Technology Acquisition. However, a number of limitations of the research were identified and these are discussed below:

(1.) Generalisation: The development of the Portfolio Management techniques and their application to the challenge of selecting the "right"

MTA projects was only applied within the sponsoring Company, to facilitate their specific requirements (which was a condition of the research funding). It is not known if the techniques that were developed could be generally applied in other manufacturing companies or industrial sectors with the same degree of acceptance and success, as this was not tested. However, both the literature review and the survey of other companies undertaking MTA clearly identified that there was a need to improve the methods used for acquiring manufacturing technology due to the high failure rates.

(2.) Quantitative Inputs: The EMB method is still heavily reliant on quantitative inputs (e.g. NPV, Cost and Savings) and is therefore open to similar degrees of inaccuracy when estimating the input variables, especially if the technology is in the embryonic stage of its development and cost-benefit data is uncertain.

(3.) Sample Selection and Completeness: Sixteen MTA projects were reviewed to establish the lists of factors and measures. Although these interviews yielded comprehensive lists, the completeness of the final listing has not been verified. The single case study in chapter seven generated one additional new factor. To counter this, the number of new factors and measures found per interview decreased as the interviews progressed, as repetition of factors and measures began to occur. This indicates an approach to completeness in the list of factors.

(4.) Definitions: No definitions were developed for each of the individual factors and measures. This is a common weakness in most studies into success factors (Balachandra and Friar, 1997). Therefore, what exactly is meant by some of the factors and measures is open to some degree of interpretation. This could have been rectified by a larger study, but it was decided to broaden the research rather than deepen it.

(5.) Single Case Study: Only one project was examined at a very detailed level over its lifecycle (Auto Loader Project) which confirmed the earlier research findings and generated some emergent concepts. The use of a single case, although valid as a research method, leads to questions concerning external validity or applicability to other organisations. Would similar events have taken place in other projects in other companies?

(6.) Strategic Change: The rate of change in leadership and its associated impact being frequent changes in the strategic direction of the Company had an immense impact. Furthermore, the effect these strategic change events (SCE's) had on MTA activities was almost catastrophic. It is not known whether the same degree of change occurs in other manufacturing companies causing a similar level of impact.

9.7 Further Research

The field of Manufacturing Technology Acquisition has much potential for further research. Much of the work published to date has focused on a single aspect of implementing manufacturing technology, as discussed previously. The main topics identified as requiring further investigation following the work reported here include:

(1.) A quantitative study into the relative importance of each of the factors identified as contributing to success or failure when undertaking MTA would be of value. This should occur only after having clearly defined each factor's meaning and validating statistically the completeness of the list of factors. This research could yield a hierarchy of factors in terms of their relative importance for a given type of MTA project.

(2.) The research on success factors could be extended to include a study to establish which factors are applicable at each stage in a MTA project's lifecycle, from concept generation through to project completion. The stages in a project lifecycle would need to be clearly defined in advance in order to correlate the importance of each factor with the different stages of the project.

(3.) There was a noticeable clustering of technical factors stated as contributing to failed projects. Also, although the single case study was destined to have multiple causes of failure, the first reasons found to have caused failure were technical in nature. Do MTA projects fail primarily due to factors found in the Technical Category? If this were discovered to be the case, it would place more emphasis on design for reliability and on the technical assessment of equipment prior to acquisition.

(4.) The single case study on the Auto Loader showed that 53 factors were present during the project, yet in both the earlier phase of the research work and in the literature on success factors, only a few factors were mentioned for each project. Is this because the project was examined at a very detailed level over a long period of time as it was actually happening in the factory, or is it because there really are that many factors at play during MTA projects but respondents can not recall them all after the event? Are there really so many factors at play during a given project and does this complexity create an opportunity for things to go wrong, thereby contributing to the high levels of failure in MTA?

(5.) The portfolio techniques and the EMB method developed for selecting and prioritising projects could be tested out in other manufacturing companies. This could incorporate an investigation by industrial sector to see if the MTA model is applicable across a range of industry types.

(6.) A study could be carried out to compare the success rates of MTA projects using traditional methods (DCF, payback, IRR) with those projects selected using the new MTA model, to establish the relative success of the two methods in a number of manufacturing companies.

(7.) As manufacturing technology can be acquired via many sources, ranging from internal R&D through to straight purchase from a machine supplier, it would be interesting to study the success rates for each of the different means of acquiring technology to examine how this impacts on the probability of success.

(8.) The impact of strategic change on MTA activities merits further research, as it clearly played a significant part in the case of Fruit of the Loom. Was this a unique situation or do strategic change events occur as frequently in other companies and is their impact as devastating? Can one single factor (strategy) out of the 76 established, be significant enough to result in failure?

The area of research which would most enrich the results of the current study is, in the author's opinion, case study research aimed at further testing the portfolio management and EMB project selection methods (numbers 5 & 6 above). This would confirm the researcher's own experience and indeed these research findings that selecting the "right" projects in the first place is a key step in improving the overall chance of success, given that simple financial techniques remain the dominant method by which manufacturing technology investment decisions are made.

9.8 Recommendations for the Company

As Fruit of the Loom Ltd. sponsored the research, it is important to include a number of recommendations specific to Company:

(1.) The methods developed for MTA have proven to be successful and have gained general acceptance within the Company. However, the restrictions on expenditure in the late 1990's meant that MTA activities were curtailed for a period of time when the Company went into bankruptcy (known in the U.S. as Chapter 11 protection from creditors). The Company has been acquired by Berkshire Hathaway, Inc and is now on a sound financial footing, free from the burden of debt. Finance has become available again in 2002 to invest in manufacturing technology, with approximately $4 million being allocated for investment this year alone. The Company has decided to reintroduce all of the previously developed portfolio management techniques, including bubble diagrams and EMB. It is recommended that the Company ensure that the methods developed for undertaking MTA are reintroduced now that the strategic direction is much clearer.

(2.) It is also recommended that the five-person MTA Review Panel reconvened for the 2002 annual project selection round also be involved in the 2003 MTA process.

(3.) The new MTA model and the associated guidelines developed for using it should be fully implemented and its use explained and communicated to all interested parties in the Company.

(4.) If further enhancements are identified through using the MTA methodology, they should be tested and implemented accordingly, subject to review by the MTA Review Panel members.

(5.) Strategic direction should be validated at appropriate intervals, up to CEO level, to ensure that the likelihood of SCE's happening is minimised or at least that those senior managers operating in the European manufacturing division get early notification of any possible strategic changes that may impact MTA activities. This will enable the Review Panel to reassess the project portfolio in a timely manner.

(6.) The activities of the MTA department should be fully aligned with the Company's business strategy in Europe.

(7.) Technical resources should be maintained at a level necessary to support the portfolio of projects.

9.9 Conclusions

This research was carried out with the objective of improving the chances of success when acquiring manufacturing technology. The fundamental challenge was firstly to select the right MTA projects and having chosen them, how to make them successful. This research question was driven by the author's direct experience of having observed many manufacturing technology projects fail in the Company.

The literature supported the researcher's observations with failure rates reported as being between 50%-75%. An external survey of sixteen MTA projects confirmed that failure in acquiring manufacturing equipment occurs relatively often.

The research yielded a comprehensive list of factors (76) that can contribute to success or failure. A further list of measures (38) used to determine whether projects succeeded or failed was obtained. With such a large number of factors and variables involved, it is not surprising that some projects fail.

To improve the chances of success, methods were adopted from the fields of NPD and R&D and adapted for use in MTA. The challenge of selecting the right projects was improved by the development of the Expected Manufacturing Benefit (EMB) formula for ranking projects, using a multi-criterion analysis encompassing costs, benefits, strategy and technical risk. This delivered a different list of projects than would have been obtained using the traditional project selection methods for manufacturing technology investment decision making- Payback, DCF and IRR.

The contribution of the research was the development of new techniques for acquiring manufacturing technology. These methods were modified and enhanced over three annual project selection cycles resulting in a novel method for MTA project selection being proposed. The components of the research were brought together in a new model for MTA, which was developed along with a 24-step process for selecting projects, based on a rank ordering of the projects in the portfolio. These 24 steps guide the practitioner through the process. The research represented a significant step forward in terms of the methodologies available for those involved in MTA and offered a new and alternative approach to the subject.

It is hoped that the conclusions of this research will find practical applications in other manufacturing companies and lead to improvements in success rates in Manufacturing Technology Acquisition.

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APPENDICES CONTENT

APPENDIX A (i)

BERKSHIRE HATHAWAY INC.
NEWS RELEASE

FOR IMMEDIATE RELEASE

April 30, 2002

BERKSHIRE HATHAWAY INC.

Contact:
Marc D. Hamburg
Phone: (402) 346-1400

FRUIT OF THE LOOM

Contact:
Stephanie Hoefken
Richards/Gravelle
Phone: (214) 891-7693
stephanie_hoefken@richards.com

BERKSHIRE HATHAWAY COMPLETES ACQUISITION OF FRUIT OF THE LOOM

April 30, 2002 ¾ Omaha, Nebraska (BRK.A, BRK.B). Berkshire Hathaway Inc. announced today the consummation of its purchase of substantially all of Fruit of the Loom's business operations.

The order of the U.S. Bankruptcy Court for the District of Delaware confirming the Joint Plan of Reorganization of Fruit of the Loom and its subsidiaries became final yesterday, April 29, 2002. Berkshire's acquisition completes Fruit of the Loom's emergence from bankruptcy under the Plan approved by its creditors and the Court.

Fruit of the Loom, headquartered in Bowling Green, Kentucky, will operate as an independent, wholly owned subsidiary of Berkshire Hathaway Inc.

Berkshire Hathaway Inc. is a holding company owning subsidiaries engaged in a number of diverse business activities. The most important of these is the property and casualty insurance business conducted on both a direct and reinsurance basis through a number of subsidiaries.

Fruit of the Loom is a leading international vertically integrated basic apparel company, emphasizing branded products for consumers of all ages. The Company is one of the world's largest manufacturers and marketers of men's and boys' underwear, women's and girls' underwear, printable T-shirts and fleece for the activewear industry, casualwear and childrenswear. Fruit of the Loom employs approximately 23,000 people in over 50 locations worldwide. The Company sells its products principally under the FRUIT OF THE LOOM® and BVD® brands. For more information about the Company and its products, visit http://www.fruit.com.

APPENDIX B (i)

KEY WORDS LISTING

(Sample)

PROCESS
PROCESSING
RESEARCH
RESEARCH & DEVELOPMENT
RESEARCH & DEVELOPMENT MANAGEMENT
INNOVATIONS
PRODUCTION
PRODUCTION MANAGEMENT
TECHNOLOGY
TECHNOLOGY MANAGEMENT
TECHNOLOGIES
TECHNOLOGICAL
TECHNOLOGICAL MANAGEMENT
ACQUISITION
TECHNOLOGY ACQUISITION
TECHNOLOGY TRANSFER
ACQUIRING
BUY
BUYING
PURCHASE
PURCHASING
COMPETITIVE
COMPETITVE ADVANTAGE
STRATEGY
STRATEGIES
STRATEGIC
MASS PRODUCTION
TECHNOLOGICAL PLANNING
PROCESS
PROCESS DEVELOPMENT
PROCESS ENGINEERING
PROCESSING
PRODUCTION
PRODUCTION ENGINEERING
MANUFACTURING
MANUAFCTURING TECHNOLOGY
MANUFACTURING SYSTEMS
PRODUCT DEVELOPMENT
PRODUCT ENGINEERING
PROJECT MANAGEMENT

APPENDIX B (ii)

See MS Access CD ROM in sleeve attached to back cover of thesis.

APPENDIX C (i)

R&D Management Centre, Cranfield University

Our field of research

We describe our field of interest as 'the business concerns of the industrial scientist or engineer. This can embrace tasks variously described as Management of Research and Development, Management of Technology, or Innovation Management. We aim to promote competitive advantage through greater professionalism in the management aspects of the R&D function.

What sort of new projects are suitable?

We do not produce a project list. All projects originate from the practical work problems of our students. Research topics need to be important to the researcher's employing organisation, and must promise to be of value to the researcher in carrying out his or her work. The researcher must be able to use some of the employer's time and facilities in support of the research.

Our experience is that a topic which arises out of a practitioner's personal experiences and needs often proves, when a literature search is undertaken, to be surprisingly novel. When there do exist previous academic publications in the field of interest, our students often find that these yield guidance which is of only limited value in helping them to perform their jobs. The starting point for a research project is therefore a practical problem at work. One reason for the effectiveness of our research is that our students have natural access to the daily practice of the problem they are investigating, and easy entrée to people with similar problems in other organisations.

Often at the beginning there is only a general idea about a possibly important research area, and the exact nature of the problem does not become clear until the student has started work and systematically developed specific research objectives and methods. We find that it is worthwhile to devote quite a large proportion of the project time to defining the research problem and formulating a research plan that will yield a valuable output.

APPENDIX D (i)

Fruit of the Loom International Ltd

Ballymacarry
Buncrana
County Donegal
Ireland

3 April 1997

Du Pont (UK) Ltd
Maydown Works
Londonderry

Phone 00 353 77 62222
Fax 00 353 77 62858
email m.mallon@ftlbc.fruit.com

Dear Mr McCormick,

I am Group Technical Manager of Fruit of the Loom International Ltd and also a part-time PhD student at the R&D Management Centre at the School of Mechanical Engineering, Cranfield University. I am writing to ask for your help with my research, which is aimed at finding what factors promote success when acquiring technology for manufacturing.

In my experience many projects go less well than expected, or even fail entirely, and I wish to draw on a wide body of experience in finding out the reasons for this. In the first phase of the research I wish to carry out a series of interviews with people who have experience of bringing new technology into manufacturing. These interviews will be aimed at identifying key themes for further investigation.

Interviews will be confidential, but will be tape-recorded to facilitate analysis using a technique known as Content Analysis. A proposed agenda is outlined below, but I want to explore all the issues that you believe to be of relevance. The duration of the interview will be 30 to 45 minutes. All participants will receive a summary of the findings of the interviews.

Interview Agenda:

Respondent's and Company's background
One successful or one unsuccessful project that you have personal experience of
How well these projects proceeded
What went right and what went wrong
Parties involved in the projects
Appraisal of project outcomes
Other issues

I hope that you will be able to participate in this investigation, which should benefit all of us involved in manufacturing. I will call you next week to ask what time and place would be suitable for you.

Sincerely,

Michael Mallon
Group Technical Manager

APPENDIX D (ii)

Project Number : 3
Interviewee : Colm McKeever
Position : Operations Director
Role in Project : Project Engineer (previous company)
Project : Acquisition of Automobile Airbag Manufacturing Technology
Project Cost : £5,000,000 Capital - 4 months duration

Outcome : Unsuccessful

Project Description

The Acquisition of Automobile Airbag manufacturing technology from parent company in Japan.

Means of Acquisition

Technology transfer

Acquisition Process / Sequence of Events

Directive from Parent Company to transfer machines from Japan to U.K.

Success Measures

The equipment wasn't capable of doing the work that was expected of it - I actually ended up going out and buying replacement equipment

Time period of one month after implementation to get it into production

Quality of production

Production quantity

The set of machines required constant adjustment and setting to produce any parts

We were so far away from what we realised was the target and the measures we had to sit down and take this thing serious

To determine what could get us back on an even keel

Although it had ran for a period of time in Japan, it just wasn't suitable for our application

We were already over and above our budget (when we decided to buy new equipment), but we were already in dire trouble, we simply had to take the decision to go with new equipment and to put forward the proposal to do it

Critical Factors - Success / Failure

The actual design of the equipment - as its original fit-for-purpose criteria was wrong

A lot of it was older technology which wasn't computer controlled and which wasn't easy to reset and change for the type of operations we were doing on it

We knew that the right equipment existed in the marketplace and over its life, it would be much easier to maintain

We would end up spending as much money trying to keep the other equipment running, albeit not getting what we wanted out of it compared to buying proper new kit

Some of the stuff that was sent from Japan was very difficult for us to get people to work on and gets parts for it

This equipment wasn't available in the European market and therefore people didn't know how to work at it or where to get parts for it as well

We also had major Sales problems

Major Equipment problems - bespoke equipment supplied from Japan didn't work

You've got to have a very clear understanding of what you are buying it for

You've got to have had carried out a very thorough appraisal.... that you're going to get your money back

The whole appraisal and decision phase needs to be very carefully looked at...that you are buying and installing what you think you are installing and that it will actually do the job you want it to do - CIM is the one area where this happens more than anywhere else

Key People

Operators
R&D
Engineers
General Managers

Other Points / General Comments

Certainly in my eyes, it was a disaster

We wheeled the equipment into the store and left it there

The equipment was made by our parent company in Japan and sent across to do a particular job, but it was incapable of doing that job - both parties agreed to that in the end

I had to pull the plug

The Japanese just wanted to lift their line out of the factory in Japan and send it to us directly, but it just didn't work like that - and they admitted that in the end themselves....by the time they had realised that, I already had new equipment in the line from Europe

Shortly after that we had major sales problems where the market that should have been there wasn't there, and we weren't established enough in the marketplace to see us through that period.

People go and see a bit of kit at a show or at competitors and say oh I'll have that, and go and buy it and really they may not have the use for it that merits buying it

IT Acquisitions....my experience is that very few of them actually perform to what they are supposed to be doing. I've been in three companies in the past five years and each one of them has spent significant amounts of money on software that isn't running properly. The problem is, because it's not measured in parts per hour {like machines}, people put up with it and they get used to the fact we've spent one-hundred grand last year on a system but we're not really getting anything out of it

The computer industry are specialists at selling you something that you don't need or that you think is going to do your job and it doesn't - when they get it in there, it doesn't really matter

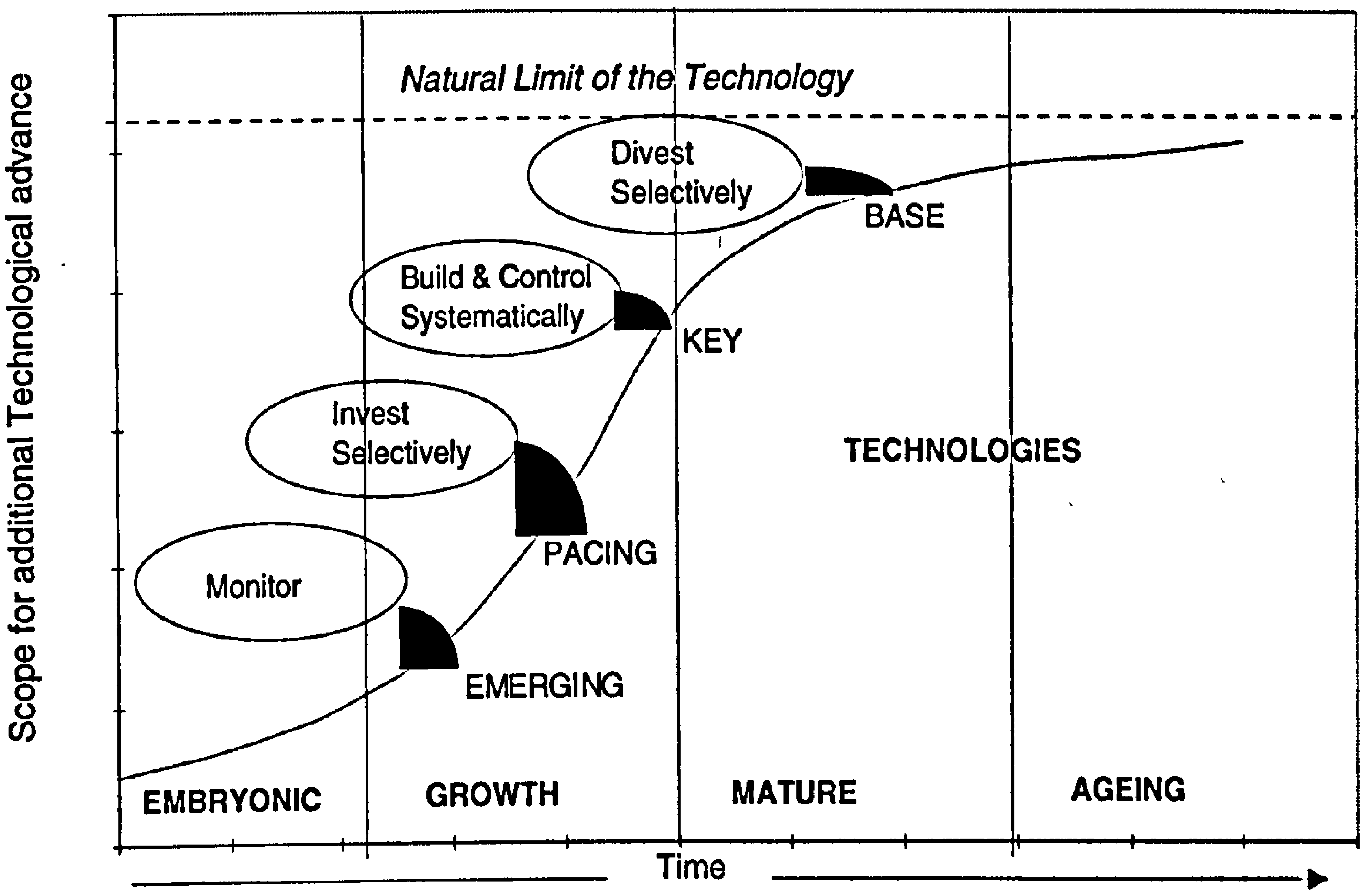
That would be my biggest area {IT} that I would be extremely "gun-shy" of and I would be nervous about getting a return from.

APPENDIX D (iii)

INTERVIEW SUMMARIES

Project #	4	6	8	10	11	12
Project Description	Automated Folding Technology	Automated Sewing Technology	Kevlar Manufacturing Technology	Mechanisation of finished product materials handling	Medical Packaging Manufacturing Technology	Automated Sewing Technology
Acquisition Type	90/10 Joint Development with New Supplier	Off-the-shelf Purchase	Combination - Internal R&D, Buying-in & Supplier R&D (60/40)	Joint development with supplier - R&D	Collaborative development - 70% Internal R&D / 30% Supplier	Purchase from Supplier
Duration	2 Yrs	12 months	24 months	2 years	18 months	3 years
Cost	£160,000	$530,000	£65,000 000	£1,500,000	£500,000	$500 000
Outcome	Successful	Unsuccessful	Successful	Unsuccessful	Successful	Successful (eventually)
Factors	Design modifications specified Narrowed down Suppliers Confidence in Suppliers Know available technologies Good relationship with Supplier Structured Project approach Trial Run Top Management support Production people involved Integrated Project Team Peoples' background Let's do it mentality Willing to spend money	Wasted resources Time taken Lack of documented evidence on project progression No control No system Format of information for users Machine unsuitable Lack of Resources Departmental Structure Poor ROI External Factors - industry state Lack of Will & intent Lack of clear direction Lack of support from vendor Lack of experience - our resources Lack of knowledge - project mgt Set-up problems - mechanical	Team composition - right people Good balance in team Good documentation Good implementation Vision of what we wanted to achieve. Explained the vision. Understood customer needs / wants Customer Survey Understood Process fundamentals - science Questions - why, why, why? Internal competition People from different disciplines Team approach Defined functionality early on Kept reviewing scope at R&D stage Project Plan	Over schedule Functionality required was not attained. Customer needs not identified Push system - not Pull Poor process design & definition Wrong starting point in process Links with vendor not close enough Compromises made in scope Engineer lost sight of objectives Business economics were not there Not the right person for the job Engineer's knowledge of Project Mgt Engineer's knowledge of the technology Requirements not clearly understood	Need for Project In-house ownership of concept In-house ownership of design Individual had ownership Individual was identified with project	Preventive maintenance programme Spare machine, could work off-line Required extra technicians - resources Machine upgrade part way through Slow start - not many machines
Measures	Savings (cost reduction) Availability of space for growth Ergonomic benefits (H&S) Reduced operator training times Frequency of problems Marketing Machine downtime Flexibility Customer / Rejects	Successful implementation Working efficiently Time taken Production Output Quality Operating Cost Equipment cost Meet Objectives Data integrity	Functionality Project Costs On budget - capital + non-capital Start-time Quality Supply chain integration Business objectives & Strategy Production output Efficiencies	Time taken Functionality Business needs System up-time (downtime)	Machine validation Payback - cost reduction Installation success Operational success - downtime Process success Defect levels of product output Throughput Set-up times / changeover times Quality	Production Output Quality Deskill Operation Cost Savings Efficiency Downtime Time taken
People	Marketing Engineers Production Supervisors Top Management Quality Suppliers	Engineers Supplier Operators Production	Team Leader CF Project Teams 17 people in total	Engineer Supplier Production people - during implementation	Small team - 3 people Engineering Manager Quality Manager General Manager	General Manager Manufacturing Engineers / mechanics Supervisor Sewing Project Manager Supplier Operators
Process	Visited Trade Shows Supplier presentations in plant Decision to trial machine. Monitor - 9 months Involve US Management "Mushroom" effect Second Trial Major Investment Systems Integration	No formal Technology Acquisition process. Supplier informed company of new product. Working in competitor's factory Get it in and install it. Some basic training	Initial Analysis - what we wanted Core Team (4) Examine business objectives Project Scope Functionality required Project Plan - CAC, VG Determine criteria Authorisation & Implementation On going review	R&D work in-house and with supplier Spec provided	Cost / Benefit analysis Decision to proceed	Not discussed - wasn't sure
Others		No Stage-gate Gave new model for what would happen today		We should have stopped the project earlier on Engineer couldn't recognise the bad news.	Project team meetings Training of all personnel Committed to process and production technology improvement	Learning everyday Training is very important

APPENDIX E (i) Technology Lifecycle illustration.



APPENDIX F (i) Characteristics of the Three Types of R&D (Third Generation R&D, Roussel et al, 1991, p54)

Types of R&D	Characteristics of the Type
Incremental	Normally, the clever exploitation of existing scientific and engineering knowledge in new ways; characterized by low risk and modest reward
Radical	The creation of knowledge new to the company – and possibly new to the world – for a specified business objective; characterized by higher risk and higher reward
Fundamental	The creation of knowledge new to the company – and probably new to the world – to broaden and deepen a company's understanding of a scientific or engineering arena; characterized by high risk and uncertain applicability to business needs

APPENDIX G (i)

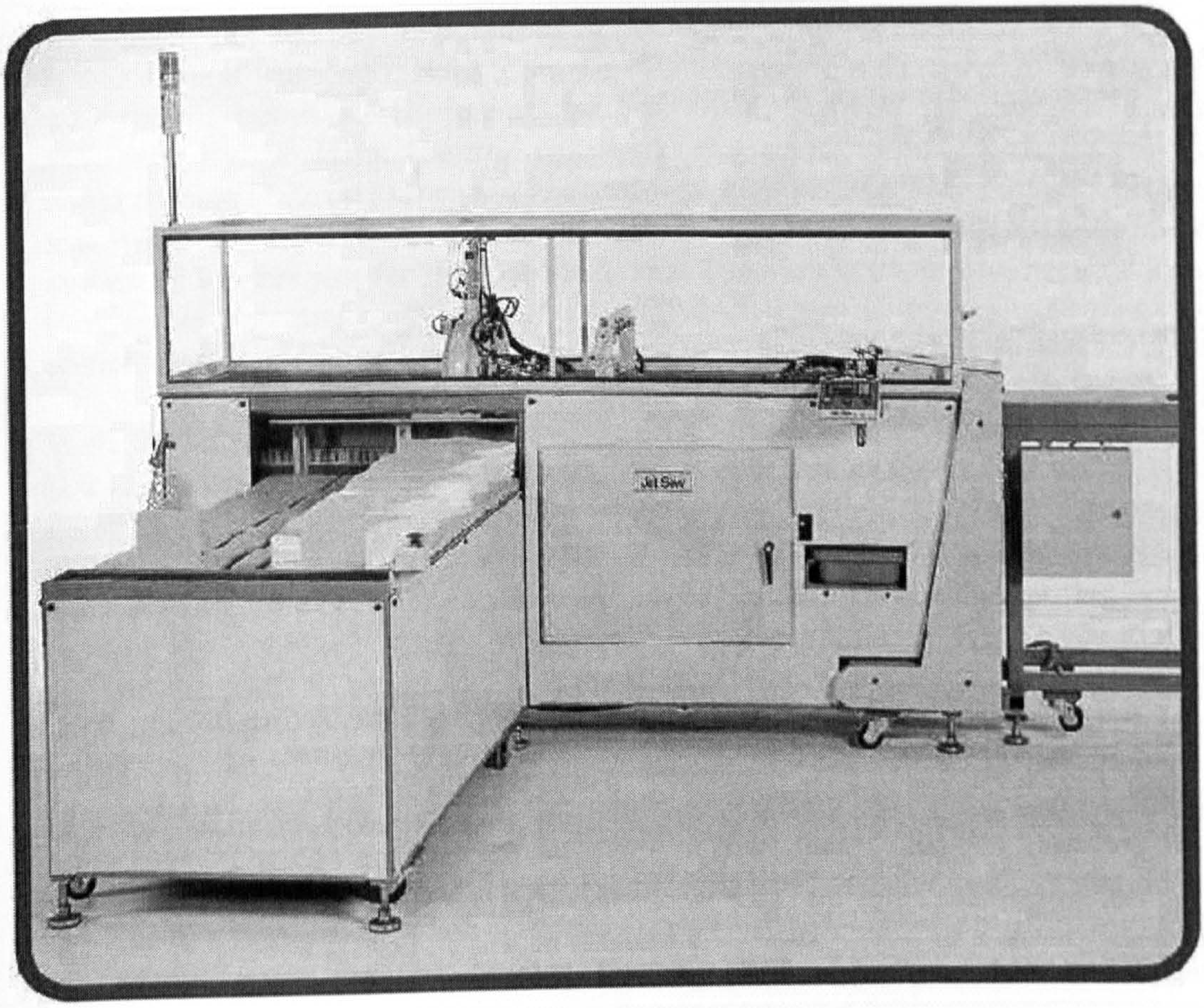
Jet Sew Brochure.

Jet Sew

Model 5043

Knit Sleeve Feeder

With the Jet Sew Model 5043 Knit Sleeve Feeder, short sleeve plies can be continuously loaded onto the conveyor of a hemmer or hemmer/seamer system. Both sleeves cut on the fold, or cut open face-to-face can be loaded. One operator can run up to three units, with each unit feeding up to 28 pieces per minute.



Model 5043

HOW IT WORKS:

1.) Several precut stacks of sleeve plies are loaded onto the machine's infeed conveyor.

2.) The leading stack enters the machine, where its top ply is picked up.

3.) The ply is deposited evenly on the main conveyor. During this operation, folded plies are opened.

4.) For stacks cut face to face, alternate plies are turned over and all plies are deposited face up.

5.) A face-up detection system ensures that all plies have the proper orientation.

5.) As plies are transferred to the hemmer or hemmer/seamer conveyor, an advanced aligning system orients their edges to the folder.

FEATURES:

- User-friendly electronic control.
- Advanced edge aligner for consistent orientation of sleeve plies.
- Large infeed conveyor allows continuous operation. Up to five precut stacks at a time can be loaded.
- Operator can tend up to three machines simultaneously.
- Accepts sizes S to XXL.
- Processes up to 28 pieces per minute.
- Defective ply removal system.

SPECIFICATIONS:

- Outside dimensions: 96" x 96" (240cm x 240cm)
- Weight: 750 lbs. (338 kg.)
- Electrical: 220 VAC, 3 Ph, 60 Hz
- Air: 80 PSI, 8 SCFM

Printed in U.S.A.

Jet Sew Technologies, Inc.
8119 State Route 12
P. O. Box 320
Barneveld, NY 13304-0320 USA
Tel.: (315) 896-2383 / (800) 765-9374
Fax: (315) 896-6179

APPENDIX G (ii)

Examples of Interviews (two examples).

Interview No: 1

Project: **Jet Sew Automatic Loader**
Interviewee: **Ernst Schramayr**
Position: **President, Jet Sew Technologies, Inc.**
Location: **Barneveld, New York**
Date: **3 April 1998**

Q. Why was the need for this particular loader (machine) identified and where was it driven from?

When Fruit of the Loom had acquired many Union Special Hemmer Seamers, this was during the years when Brad Clarke (Senior VP Manufacturing) and all these people were going out and buying hundreds of machines...I don't know the exact year now but it was several years ago. Hank Cantrell (VP Corporate R&D) was given the task...this was the in house R&D department...of what can you do to load this machine automatically. So Hank Cantrell called me and said: " Look, what do you think we could do here?"...you know, and I sort of hijacked the project from him, because once I saw what the need was, that there was a need for maybe one hundred and fifty automatic loaders just for Fruit of the Loom, I saw an opportunity, because I'm always looking for potential commercial opportunities...where is there a need that we can do something.

Well, we had done a project prior to that which was for the Defence Logistics Agency (DLA) which was to take camouflage uniform cut parts, that had been cut "face-to-face", to separate them into stacks of only "face-up" material, or only "face-down" material, recombine it, and so on, which is the predecessor of this machine. So as I was thinking about the need for an automatic loader, and looking at the various factors – because the machine had to be very good – because you had to feed in material that was cut "on-the-fold" where every ply is the same, material that is "face-to-face" – where every other ply has to be turned – this was on the input side (of the machine). On the output side, where you had to feed machines that were "two-needle bottom coverstitch", where the material has to go into the machines "face-up" and for "blind-hemming", where the material has to go into the machine "face-down". So you have two different input modes, and two different output modes, so you have nay, many variables here.

So, that concept that we had developed for the DLA, of being able to separate stacks and being able to recombine them in different ways, this basic concept could work here. It's not the same thing, but the basic concept of a continuous running thing, where we pick it up and off-load it in a certain way. From that, I developed myself a sort of a concept idea for the machine and brought it back to Hank Cantrell and said: "listen, we have done this. I think we can do this". This is how I hijacked it, he said: "you are right and you might as well do it, it is not a project for us". That is how we got into it.

We then built a prototype machine. Now, again the difficulty was that they (Fruit of the Loom) weren't quite sure - I could not get clear information from Corporate were they going to cut "on-the-fold" everything, or were they going to cut "on-the-open". One plant told me one thing, another plant told me something else, so I said the machine would have to be versatile. It is more difficult to develop a machine that has to separate "face-to-face" plies. You have to detect the right side up (of cloth) and so on. So I identified Martin Mills (a plant in Louisiana) where they were only cutting material "on-the-fold" and said let's develop that portion of the machine first. But let's also build the machine in such a way that it could eventually be expanded into also "face-to-face" applications.

Q. How long did it take from the original generation of the need for the machine to this prototype?

We probably had a prototype in about a year. But I think was because – this may seem long to you – but it was actually short because we already had some technology. For instance, the pick-up device that we found was suitable for this endless belt with windows we had already developed some place else. So it took about a year to get a prototype going. We brought this machine to Martin Mills and it worked actually reasonably well. We then built a second machine because it was only reasonable to operate them in tandem. But it turned out the machine was getting to be too expensive for their needs. At the time we were not transferring at cost, we were still selling at an arm's length with a full mark-up and the payback was very important. They required a payback of no more than one year maximum.

Q. Were there any technical issues at stage, other than monetary?

Yes, definitely. One of the big ones was "edge-guiding". How do we guide all of the plies in (to the machine)? Now we had taken the edge-guiding system from the Sahl bottom hemming machine and applied it there and said if it works well there, it should work well here, except it is rather expensive, it is fragile and so on. But we had these machines and it worked well. This was one aspect. I think also very much on the company's side, the material preparation because it was very hard to get them to take the stacks the way they are, the way they come off the cutting machine, which is very nice and in beautiful stacks – that's what we need on our machine – it helps us, but in the intervening period (handling), they mess them up. They tie them together; they throw them in boxes. By the time you take them out, they are no longer suitable for robotic loading. So to teach them to do this took quite some time. Once they did this, it made a big difference, it immediately worked better. Also, we found that the machines were a bit too expensive because of the payback. One was the edge-guiding system, the other one was because we fabricated this entire "long-chain" using roller chain and putting slats in between that were individually attached. I don't know where we found this idea of – we saw an extruded plate chain of plastic and we said we can cut this apart and take it to a small chain and join it to a wide chain if that's what we're using now.

All this had to evolve, and we started with beautiful white conveyors as a belt screen. But then because we had to detect the right side up (of the material), we needed the camera to look at it and we had to have a dark background. The camera couldn't see the part otherwise, so we threw away all the white ones and we got black ones. So that's how it evolved, really.

Q. What happened in the plant?

We ran the machines in the plant for several months. We found that when we had our own technicians – in the beginning we actually had the project engineer personally there – he would spend there several weeks with a technician. As soon as our people left at this stage, the machine didn't go anywhere really because the local maintenance people really didn't take care of it. They hadn't taken ownership of the machine. They would say; "well, it's not our machine". If the machine did anything at all, they would call us up and say: "we shut it down because it is not working". Also, they tried to not just field-test the machine, but they actually tried to get some production out of the machine once it started to work pretty well. So they ran it three shifts, during which there was no supervision at all for the second and third shifts and it caused us a lot of problems. We then decided that if we were going to make this successful, we would have to have it manned one hundred percent of the time. So we had a person be there all the time.

I think it is also because of the level of commitment of the plant and the level of expertise of the people. They had one really good person, Norris Boulain, but everybody else was sort of ok, but not good enough for a project like this. I think this is where we could probably have much better results in Ireland, because you do have trained people – you have people that actually served an apprenticeship. Here they just come straight of the farms sometimes. I don't want to belittle that, but there is a real difference here. Very few people have formal training in the plants.

We built the first two machines and I think it was now two years ago when we actually had success. The payback wasn't perfect but it was reasonable. But then we ran into all corporate politics. At this point we ran a lot into corporate politics when people like Brad Clarke (Senior VP Manufacturing) and Donnie Watts (VP Manufacturing) would tell us: "yes we need the machines, we need them fast because we got to get production". They could see the pressure from above that production was going "off-shore" (low cost labour countries). Well I said give me an order for the machines but they really couldn't because they couldn't get the capital allocated. They said: "It's coming, coming go ahead anyway and don't waste any time". So we started the production line –we literally set up a production line to build these machine and because we wanted to do it fast, we even changed our way of producing. We normally build a "one-off" which we normally do for our special machines, we literally moved machines like on an assembly line from station to station and we started to build machines. Except I could never get the order confirmed and the machines sat around for six months, we had an inventory and then they finally said no, cancel –everything is cancelled. It was a huge investment, and this was during a time when Fruit of the Loom would not allow us to sell outside. Any new development that was relevant to knitwear production was proprietary and they would let us sell it to competitors.

Q. Did they give you a reason as to why it was cancelled?

Because they were going offshore. It seems that there was a real conflict between upper management strategy – their long-range strategy – and the people in manufacturing. They were never really told. Manufacturing seemed to have their own agenda which was keep production domestic (in U.S.A.) while senior management had already a strategy for going off-shore, probably one-hundred percent. And then there was this numbers game where Gary Wood (Senior VP Manufacturing Off-Shore) was then appointed to open up a plant in Honduras, while his equals (other manufacturing VP's) were trying to shore up domestic production.

We had management meetings once or twice per year, and we as the research arm of the corporation would make these presentations with videos and so on, and I showed him all these great projects we have. I even quoted numbers –we can save thirty percent on this operation, and ninety percent on that operation' like on our fleece project. Gary Wood would sit in the front row, and he is a very gentle person, and so at the same meeting there would be two vice presidents. I would go to the Executive Vice President, Stan Vinson, and say: "Stan, what is going on here? Gary says within a year all production will be off-shore, and here (at Jet Sew) we are spending and making." He said we should keep going as we could probably take the technology offshore eventually, and that we had to keep a mix of fifty-fifty, half offshore, half domestic. So manufacturing saw that they were losing ground, but they were still hoping that they could keep half of their plants here (U.S.A.). Senior management never told them it was their strategy to shut down here and go offshore. They never told them, or if they told them they wouldn't believe it.

So here we were John Holland (Vice Chairman) who is still very impressed with what I had presented. Only a year earlier, during another management meeting in Nashville, Tennessee, he got up and said: "you will have our unlimited support. You will have Fruit of the Loom's unlimited support". During the break, some of the other VP's came and said that they would like to have it that good – unlimited support from the Vice-Chairman. They said they could never get anything, and here you are going to get unlimited support. Well, I didn't have it, as that was the intention of the vice-chairman and not the chairman.

So there was confusion within the company and what happened then, even worse than that, is that the manufacturing management were not being honest with the senior management. They used us, Jet Sew, as an excuse or front as said: "we've got to get those machines from Jet Sew as Jet Sew need the work". There was one meeting where senior management said: "You better go out and get yourself your own work, we cannot keep supporting you". I said I don't want you to support me at all. I wish I could sell outside. But there was this total conflict within the company which then resulted in all kinds of people getting fired and plants being closed down and so on, and all our projects dead.

Q. On the loader then what did you actually do?

We had the loaders down in Martin Mills: we got the numbers; they worked well; we had videotape showing it. We brought them back (to Jet Sew) and redesigned the machines, we used lower cost methods and we started a production line. The two machines are still here and we scrapped three machines. In the United States, we only have one major company that is interested in it, because of this stampede to offshore production. Don't forget NAFTA (North American Free Trade Agreement) was just passed during that time, which doesn't have at all a level playing field. How can we have the same playing field with labour rates in Mexico? It has become a stampede, and where we thought as little as two years ago the new management, this Dick Lappin told us: "you will never have to worry about another order again", and they actually gave us AFE's (Authorisation For Expenditure) for twenty machines. We had a go situation. They said the capital investment to automate is no greater than the cost avoidance of not having to build a plant in Mexico. It was about the same cost. A new plant in Mexico cost about the same as it would for us to automate an existing plant so therefore it was a wash there. The manufacturing costs using automation was essentially the same as using manual labour in Mexico, when you had factored in transportation, pack and re-pack, unloading, etc. so I said wonderful, let's go with this. But Farley (Chairman) never agreed to that, and he would not sign-off. He then whittled it down from twenty machines to two machines, just like for a demonstration project, and he finally cancelled that too.

The entire thing came to a standstill. Now during a year of confusion, which was in 1996, Jet Sew was going bankrupt because we were tied up not to sell outside, but they were not buying anything inside. One side was till telling us: "develop, develop, develop", and we were spending millions of dollars in development to try and perfect these projects, while on the other side senior management was telling us they were never going to buy it. It was terrible – we were in the red.

So then they came here to Jet Sew and said: "Should we continue our investment in Jet Sew? Maybe we should just shut it down because it's just getting too expensive". It was totally ridiculous. I said just take my handcuffs off, and let me show you that... just leave us alone, let us do our thing. I stopped all apparel projects and did a one hundred and eighty-degree turn and went to textiles – wash cloths and these things – because I felt apparel had the stampede offshore. I can develop business, and that's what we're doing.

We still have all this technology sitting there; it's dormant and today sales to apparel represents less than ten percent of our business whereas on time it was one hundred percent. We have it (the technology), we've invested heavily in it and we have tremendous know-how and we've learned how to sew, how to robotically move fragile stuff, etc. and if there is somebody interested in buying a sufficient number of machines, off-course I want to look at it –I'm not turning it down. There were mostly external factors (as opposed to technical or inside Jet Sew).

Q. Would you regard them as being outside of your control?

Definitely, Definitely – these were outside of our control. In fact, I was being misled. Not people that would deliberately want to mislead me, but they were not being totally honest. They were being self-serving and they were hoping that if they could get us to come up with this great solution, then maybe they could change the mind of senior management. But, they never told me how risky this really was. They just said you go ahead and do it.

The loaders that we built were never really completed – we do not have completed loaders in stock. First of all, these loaders were built for only for material cut "on-the-fold" because the first thrust was that way. They could have been re-equipped eventually, as we designed the machine in a modular way, but we never perfected the method of "face-to-face" loading. The frames and everything are the remnants of that first production run. I still kept them at full value in inventory as I was still hoping I could sell them one of these days.

Q. So what the loader we are about develop?

What happened here is that after we shut down the project for Fruit of the Loom, which again we had only perfected the loader that does folded material? We showed the machine at a Trade Show a couple of years ago, at the "Bobbin Show", and we got the attention of a company called Bassett-Walker. They are part of the Vanity Fair (VF) corporation, but they needed to cut material that was cut "face-to-face" and some folded. So we had to now take one of our machines and perfect this method. There were many challenges with this. One of the big challenges was to devise the face-up detection system, so we did get a camera system from Hank (Corporate R&D) and a special digitizing board, and computers, and so on. This can be rather expensive. Then we came up with this other intelligent photocell array, which is doing a very fine job.
We did this and we brought a machine to Bassett-Walker. We ran it, we....well first we brought a machine here actually; we converted a machine and they sent us a lot of material; we brought a team of their people here; we showed them the machine in operation. They had some suggestions. Our edge-guiding system wasn't really good enough. We had to adapt one of their Pegasus machines, while the original loader was designed to work with a Union Special machine, but it was pretty much versatile anyway. But, still we had to change things to make it work with a Pegasus machine. We brought the team up here, they critiqued the machine and we then said we will implement such and such changes, which took another six months and we designed quite a bit of it. Then we brought it back again and said here it is, what do you think? They said it looked quite good so we shipped it down there, and put it into a production environment. We learnt more things there.

As we were learning there, we were building a second machine for Fruit of the Loom, Ireland. As we learnt something in the field, we were adapting it here. When were learnt something here (in Jet Sew Lab), we brought it down there. We had one in the production facility and one in the Lab, which actually worked out quite well. So we could test it out here and then go down there and implement it. This machine here, which will be sent to Ireland, is the most advanced machine. In fact, Bob (Technician) will go down to Bassett-Walker and implement the changes we have made here.

Q. What are the most important factors in making this project a success in Fruit of the Loom, Ireland?

The number one issue...the overriding issue is the commitment by senior management in Ireland, to actually want to acquire this technology. In other words, they have to buy into the project. So they have to say yes, we would like to have this thing working. That's number one, because often we don't get that and nothing works in the end. So once this is there....then once this commitment has been made, this means there will be the necessary resources in terms of manpower will be allocated....in other words, a qualified technician or senior technician that will actually own the problem, that's very important. I think with Sammy Wilson (FTL Ireland Automation Engineer), to bring him over here and having him spend a week here, getting to know our people, I think will be very important because if he feels an involvement now I'm sure. We're not giving him something that he had no part in, but actually he was part of the decision making process, and can say that it looks good enough now so bring it to Ireland. So I think that is very important. Commitment from senior management; allocate the proper manpower; be willing to make the necessary changes in your system to bring the material to the machine in its proper state... undisturbed stacked....don't tie it up and stuff it in a bag – that will not work. Robots cannot handle that. If you are will to do this, I think this is mostly it. On our part, we will have our technician there for whatever time it takes. It not going to be easy to keep Bob Clemens (technician) over there for months, and I hope it won't be necessary, but you can certainly have him for a couple of weeks....we may have to have two different people go there if we really need to be there that much. Hopefully we can communicate on that well enough and with your know-how, and you knowing our people now, that we can actually do it by long-distance and we'll still go there.

It is important on our part that if you discover that needs to be improved or changed that we are responsive to it, and you have my commitment that we will be responsive to that...whatever you us to do...as long as it makes sense, we will do it. But I say the ultimate arbiter is the customer anyway. If it really doesn't make any sense to me, but it makes sense to you we will do it.

Interview 2.

Project: **Jet Sew Automatic Loader**
Interviewee: **Robert Beasock**
Position: **Programme Manager, Jet Sew Automatic Loader**
Location: **Barneveld, New York**
Date: **4 April 1998**

Q. To start with, can you give me from your perspective what your role has been in the project and some background on the project to date, from when the need was initially identified, and how the whole project came about?

Sure, I was the Project Manager for the sleeve-loading project which began, actually let me re-phrase that in our terminology, I was a Project Sponsor - all right. Basically the Project Sponsor is responsible for all aspects of the project, not just technical but financial, customer relations, finding customers to work with as a partner in the project, and the background on the sleeve-loader is as follows.

Approximately five years ago we were affiliated with the Defence Logistics Agency, which is a department of the Defence Agency, which handles all procurements for clothing for the United States Military. The Defence Department and their contractors who manufacture uniforms and battle clothing had a need for a piece of equipment which would take material which was cut face to face, turn every other ply so it was face up and then re-stack those plies so that they were all stacked face up so that they could be fed into another machine which was automated. Up to that point, no-one had been really successful in automating pieces that were cut face to face; it was a difficult thing to do. So we worked with North Carolina State University (NCSU), ourselves, a company called Ark in Tennessee, who had built a mock prototype - real basic proof of concept apparatus which actually functioned - and the reason we were proposing them was that we would use them to do that. So, we took the Ark proof of concept model and created an actual working prototype product that we could test. Working with a Project Engineer, who has since left the company, we developed an actual machine, we took it to several shows - a show in Germany - the Cologne Show, the Bobbin Show, for people to see, to see if there was any interest in it and the interest was not only military contractors but also people that made Jeans that cut face to face, some dress shirt manufacturers were cutting face to face and we saw that there could be a use for this, not at the sewing plant level that we're used to but in the cutting rooms which is kind of new to us.

Basically our affiliation with the Defence Logistics Agency fizzled out over the years - working with the University and the Government was very difficult.

Q. What Role did Ark play? What Role did NCSU play?

Ark was contracted by the DLA to build a proof of concept apparatus or a "POCA" and that's just what they did. They delivered a proof of concept apparatus that could prove what they had thought would (actually) work. NCSU was the originator of the concept, working with the Government contractors they said they defined that there's a need for this, people are flipping every other ply, you know repetitive motion syndrome, you know increased PFD. So the project originated with NCSU, was passed on to Ark and ultimately onto us here. The two predecessors were actively involved at all times as consultants; in fact we had to file monthly reports with NCSU on the status of this project to be submitted to the Government.

So now we have a machine, which will pick from a stack a single ply of material, and whether it be face up or face down, do a certain process to it that will put it in its face up orientation. The reason I bring all this up is because the essence of the sleeve loader, which is a series of open spaces followed by a series of platforms in a Ferris wheel type of construction or a round type of construction, was based on what we had learned from the original "Turn and Divide" machine which was the name of the machine from Ark. What they had done was they had taken a chain with several flighted conveyor systems on it and had a flighted conveyor systems and an opening conveyor flighted system and that's why we're back that far cause that's where it all started from. We had visited several plants, Ernst & I, - Frankfurt, Cambellsville, Jamestown, Martin Mills - to see if we could find places where we could improve production through the plants, that was our mission. We came up with several projects, one of which was the sleeve loader for the HSLT's . So working with basics that we had learned from the now defunct Turn & Divide project we conceptualised and actually built a working model of the first sleeve loader. The first one would only feed sleeves which were cut on the fold and only would feed sleeves which were face down because that was how they needed to be processed for the HSLT. We took that machine to Martin Mills in Louisiana. We ran production testing on it for several months.

Q. How long did it take from the development of the first "POCA" model to arriving at a model that you could actually implement at Martin Mills?

Because... first the two models were projects whilst similar were not the same. The basic concept of picking through a moving platform... through the opening of a wooden platform is what we took from the Ark machine. In the first phase of the project, the phase which I called the Turn & Divide phase because you would pick and turn and divide it into two stacks, that's why they call it "Turn & Divide", that took about three years from the time that Ark started it until we had a working model that we could take to a show and show people. After that there was a low in the project when we didn't know what to do with it... it turned out to be not a saleable product, it worked but it just was not a saleable.

Q. Why? What was not saleable about it?

The range of... or the parameters for which the machine was set up was the size of the product to be picked and moved was something that was determined by consultants and we took the highest percentage size available to apply to the machine, so that we didn't just have a machine which was 6" x 8" pockets, and we couldn't do shirt fronts with them.... we took the highest percentage size and applied it to the machine. Unfortunately by the time the machine was ready the sizes, or what people were wanting from us were not those sizes...it needed to flip pockets...it needed to flip waistbands, so you had Jean Waistbands, and it just wasn't a saleable product. Technologically very good, but financially a disaster. So we basically scrubbed that and said ok this is no good; it doesn't work for us.... so in our trips to all plants we said we could take that technology that we had learnt... acquired... we can apply it to sleeves cause we saw that the operators were picking and turning sleeves so there's a place that we can use that. We came back and within a year and a half we had a model at Martin Mills, the pearl type model, no castings, still had steel chain, slats and things like that. We ran it there for several months and it ran quite successfully but it was very expensive, it was all hand tooled, hand built, so we brought it back and we actually built two more advanced prototypes with castings, with hydraulic elevators, the five staging areas for the loaders and things like that. That whole process, from the time we decided to do the project until we took it to Martin Mills was about a year and a half, to the time we brought it back and we had two more machines at Martin Mills was about another year.

Q. So with the very first prototype that went to Martin Mills, what were the issues in relation to the initial trial in that plant; what were the problems?

The biggest problems that we saw at the plant were ply separation and picking consistency, as at the time we were using the one picker, and orientation of the final sleeve. The first two operations, picking and ply separation, were actually solved at the plant level, the last one which was aligning the ply which we have an aligner for now. We went through several iterations of aligning the system to get something that really would work well and work consistently and be trouble free. That whole aligning system process probably took close to two years with several people working at it.

Q. So the first prototype went back and you built two more, the advanced prototypes, what then happened in relation to those?

Again we ran those at Martin Mills. We ran production; we ran the anticipated numbers.

Q. When you say anticipated numbers you mean?

Their production... what they thought they could get out of them, with quite a bit of success and consistency over a period of weeks and months. So the machine was successful, it was ready for marketing. It had a price we thought the market could bear and it was technologically sound.

Q. During the period of running the two machines in Martin Mills, who was actually involved in the project?

There were two technicians, Bob Clemons and David Losclowsky and the Project Engineer was a gentleman by the name of Tom who now works for another company. One of our technicians was at the plant all the time... either the Project Engineer and, or the technicians or one of the technicians by himself.

Q. Who from the Plant's point of view was involved?

We had a technician working with us, his name was Vernon Beratt and one of the operators, I can't remember his name and one of the I.E (industrial engineer) guys and he had a really funny long name (Chris Freyaldenhoven).

Q. Was any Senior Management involved?

Jimmy Capritto the Plant Manager to a lesser degree, but more on a bi-monthly basis rather than a daily basis... the other gentlemen were there every day.

Q. For each of those individuals that were involved both from your organisation and the company's, what were their specific roles – name by name?

Sure, the Project Engineer his responsibility was for the technical success of the project, to solve problems that arise in in-plant testing; the technician's function was to implement those changes; my function was to tie them, our technical aspect of the machine and the financial aspect of the machine, together with the plan.... basically wise talk, oversee the project, that's too expensive sort of thing – "you can't do that, that's going to be way too expensive to produce, you need to find a alternate source – here's what I think you need to do" sort of thing. Vernon Berratt, the technician at Martin Mills was there because we were connected to their HSLT's, which we had no experience with, so he was sort of their, Fruit's technical advisor to the HSLT and while he was there he was also being taught about the loaders themselves.... although I don't recall them ever being left alone... they could have been for a week or two but I don't recall; obviously the operator was there to unload material and change thread and things like that and the Industrial Engineer, Chris, he was there doing time studies on the operator loading the machine, bundling...what they would have to do in the course of a day.

Q. How long did the trial of the two machines go on for?
About three months...it could have been 10 weeks, 11 (weeks), about three months.

Q. Then what happened at the end of that period?
We took the machines back.

Q. What was the point of that?

In order to evaluate the project properly, having one machine is not a true evaluation, an operator could sit and load it as fast as our machine so it's difficult...so we purposely made two machines so we can put a tandem set up in there, see how the operator interacts with the equipment and produce the results that we needed. They were still only prototype machines... take them out and build them as production machines.

Q. So at the end of that period, what was the viewpoint of the people in the plant in relation to the machine?

So far as did they like it or dislike it?

Q. Yes, had it achieved its objectives?

Ultimately it achieved the production objectives of the plant. The operator interfaced well with it, the layout of it was good, it didn't consume too much space and it did everything that they wanted it to do.

Q. Whenever you took the machines back to your facility, what happened next?

We looked at the machines to see what we could improve on... was there anything that was wearing out; was there anything that was too expensive to produce? was there a better way to manufacture the parts? We did what I call "value engineering", we took all the costs out of it and that resulted in the plastic components - wasn't like it was actually steel, there were chains up both sides with aluminium extruded slats across it, it was really expensive. Some other things, the platforms where the outer lays the material on, those were all made out of steel rolled together, they're vacuum form now. So basically it's bringing the machines back to value engineering and they're ready to place orders.

Q. Was there any business case or economic evaluation done at that stage?

Yes, in fact we do that several times during the phases of the project. Whenever we build a machine, we check the cost against the economic impact on the industry. We're trying to shoot for a return on investment of a year if we can, or two years... in that area someplace. So we analyse what do, we think based on our past experience what the machine will cost us in the beginning – step 1 – this machine is going to cost us $50,000, it's going to have return of 14 months – ok go ahead and proceed. Build a prototype, make it work to its potential, is that good enough for the customer. If it is, we go on... we bring the machine back, we analyse it again and say cost objective incorrect... we correct our cost analysis – yes the machine is going to cost in that neighbourhood, has anything changed from the customer's economic viewpoint? Is the 14 month payback ok?...Yes...continue...build an advanced prototype for a production machine. Also we have 29 steps, did I show them to you?

Q. Is this a standard approach that you have in the development of al machines?

Yes, every machine goes through the same process and it's something, actually Ernst (Company President) came up with it.

Q. So how, from your point of view, did you determine whether or not the project was successful - from your viewpoint as a developer?

First is that the machine meets the production requirements of the customer. Does the machine perform as we predicted it should, and we predicted it based on what the customer required?

Q. Is that purely output or are there any other measures.

Purely output. e.g. "x" number of dozens a day...you can produce a machine that will perform as you predict. The second thing that we have to weigh against that, is how much does it cost to perform that operation and most customer bases that we have been involved with in the Apparel Industry, most of them base everything on a one to two year payback. We do a simple return on investment calculation based on what it will cost the customer to produce one garment, in this case we would take one sleeve that cost a penny while with the loader it will cost 8/10ths of a penny. They do 10 million sleeves a year they will save $2 million... real basic like that... we don't put in the cost of funding, things like that.

Q. So that takes us up to the period to when the machines came back in... you did your value engineering, what happened next?

We built ten machines based on information that we had received from the United States, that they were good machines – that wasn't with me that was with Ernst and Gary Wood (VP Manufacturing, FTL).

Q. Then what happened next? Did you actually manufacture?

Yes

Q. So, what was next in the course of events, you manufactured the machines, then what?

Obviously we manufactured the parts, components... we set up an assembly line, we began producing machines and we did it. Our first group was in a group of I believe 5 units... we manufactured 5 sets of parts and what that does, that gives us a pretty good idea how much those things are going to cost us; we can't do 100 sets of parts, it can't be done that way in this particular machine. So we did that and again we looked at the cost, are we still within the confines of the parameters we set at the beginning of this, i.e. the machine needs to cost this much to make so. We were solely producing parts. We actually built the machines and we're not able to ship them cause there is no place to ship them to. There is no plants left – nobody wanted them.

Q. So what was your viewpoint on that at that particular point in time, having done this work, then suddenly from there being an order there is nothing... what happened at that particular point in time?

We needed to find another customer. We had inventory, which is expensive, and we needed to unload it so we had to seek someone else to buy the equipment.

Q. What happened?

We were able to make arrangements with Bassett Walker. We installed two machines in Bassett Walker in their current state... at that time it was the most up to date machine that we had. We installed the first machine and it ran very well, so they said so let's put another one in.. which we like doing in this type of operation. We put two machines in; they ran in tandem, they ran with our technician Bob Clemons there and ultimately they ran without us there. They were quite successful...there were still problems existing with the new machine in a production environment that we had to overcome.

Q. What type of problems?

Variations in the way the material is presented to the machine. The biggest problem we had was that their material was cut in... not in the plant where the machines were...in fact some of the material was not even cut in the State where the machines were. So it was literally transported in unipacks by trucks five or six hours away and by the time it arrived, it wasn't in a state that was really conducive to running automatic equipment so we had to work that problem out with them. But then because of that we realised that we're not going to get perfect material here, it's not going to happen, they don't cut next door, across the aisle, they cut across the State. So we needed to make the machine more flexible to stack some material that was not quite as perfect as what we would like it to be and what we did... we were able to do that...we did it on a machine that we had back here.

Q. From this second trial, were you happy with the organisation or the aspects of the project from manufacturers' point of view?

Yeah, they were really good... they were really helpful. They came up here twice to review the project with us, once with a senior management team to talk about - does the machine run right? Is there anything that they would like to see improved? Is the machine cost effective for them? Second time, they sent up their head service technician who was familiar with the Pegasus machines and one of their industrial engineers who was going to head the project from their end. They stayed up here for 3-4 days getting trained on machines... you know as much as you can do at this plant and basically learning about it, so when it came to their plant they weren't unfamiliar with it and the cooperation we got there was very good. Anything that we needed they would get us on the spot.

Q. So where is that particular project at now?

They have purchased two machines which they own. There is a set of modifications that will be installed in the first part of April (next week) to update it to take care of all the little problems that are developed by the material loading. There are other problems that we overcame...the vacuum... some adjustments that needed to be on the machine that we didn't see here ourselves.

Q. Vacuum in what area?

It's got a vacuum transfer that takes it from our conveyor to the Pegasus conveyor and we had an air generated vacuum system on it and they had some materials that were too heavy that it wouldn't pick up, and they had some materials that were so light that it would suck through... so we installed an electric vacuum that would take care of the problem. Some adjustment things that we had to put on... raising the transfer unit up and down for material thickness where the operator could do it...making the transfer unit adjustable perpendicular to the motion of the belts... things like that which we learnt there and those are incorporated on those machines now at the back.

Q. So looking at it a bit more specifically. At this stage is the machine ready to be shipped to another manufacturing location (FTL Ireland)? It's been linked to a different type of machine. What issues have there been in developing this particular application?

The number one issue that we had to overcome to hook up to the new machine was the height difference between our machine and their machine and the construction of their machine... of this new machine was not something that we were familiar with... the way the interface was. So we had to design an interface belt system between them and actually that worked out much much better than I had ever imagined. I had always thought that if you didn't have as much stuff on... if you could get rid of things you'd be better off and actually put the plies right out to the conveyor but this intermediate belt system that we came up with actually does a much nicer job than taking it apart and putting it on the conveyor belt. That had to be developed... we needed to overcome the problems that still existed at Bassett Walker for material handling with the pickers which we had implemented all these things on this machine... so those were the two areas that we were concerned about.

Q. At this stage when you look at the project (FTL project), obviously in your own test environment, do you feel that it's going to be successful?

Oh Yeah, I think it will work quite well. There will always be factors that will be weighed into it. The first of the machines that were sent to Bassett Walker, I thought would be successful and they were, if you could organise the material in almost a perfect condition. I saw that myself, if the material was stacked like paper in a copier it would run all day... unfortunately that's not the way it's going to be so it's something that we needed to overcome. I think we are waiting to see what's going to happen now when we begin running in a production environment.

Q. What do you think, from your point of view, what are the important issues for you at this point in time?

I always like to see the customer's material before a machine is shipped. I like to see it run on the machine and that's an issue that's still unresolved. I would have liked to have had the material for a week and run it through the machine and see what the different weights are... are colours a problem? The integration between the loader and the hemmer is electrically sound... it'll turn on and off and all that. I'm not certain because of our unfamiliarity with the hammer what happens if there's an error... something happens to the hemmer....are we speaking to the machine properly, electronically? That's really the two major issues.

Q. What issues do you think are important to the customer (FTL Ireland) at this stage?

I think the first thing is does this machine work...that's always important and does it produce what I need it to produce? Then not quite as important but important is what does it cost me to buy the machine, and after that what does it cost me to keep the machine running? Do I need four engineers on it every day to keep it going?

Q. In terms of the next period which is the trial and implementation, what do you think is going to be important during those weeks of the machine actually being implemented, technically in a live manufacturing environment?

What's important is that the technician is with the machine at all times whilst it is running.

Q. Your technician?

Yes, our technician. We have found that until the customer has ownership of the project, they typically won't spend as much energy making it work as we will so our technician has to be with it all the time... if he is not there it should not be run.

Q. How long do you think that would be necessary for?

I'd say probably four weeks. Because of the phase of the project, if it were a prototype, I mean the first one, it might be a little longer but because it's in its final production stage, it's productionised, it would just need three to four weeks

Q. What do you feel the technician's role would be during that period?

One: identifying and solving problems that arise; two, teaching the operator how to run the machine, and three, teaching the technician about the machine so that down the road, after he leaves and the machines are being run, the technician (in-house) has an idea how to fix or adjust something that is being done.

Q. At this stage, do you believe that Jet Sew have done everything required for the implementation of the machine other that what you said about having material?

Yes for this machine I would say that we're in good shape. The most we can prepare ourselves here for when we put in to the customer's plant. There is always more that you can do but there comes a time when you have to... I mean you can have technical manuals prepared, you can have parts manuals prepared, you can have spare parts prepared... it could be as if you are buying an automobile, you get a book and you don't have to send a technician... it could be that good but I don't think it is the industry where you can do that, I think you have to have a transfer of technology from us to the customer and that technology is in the form of what we know about the machine and we're going to transfer that to the customer. I feel that with this project we are as prepared as we have ever been when send a machine into the field.

Q. What do you feel are the risks at this stage?

As far as with this particular project there is very little risk, it's a very low risk project... we are the owner, we have nothing to lose. It's not as though we're going to invest hundreds of thousands of dollars into the development of something to try it; we've already done that... we only need now to try it.

Q. What would you like to see from the customer when they receive the technology?

A big order (laughs). I think the customer needs to have someone at their end as a sponsor of the project... someone who takes ownership of the project in their plant...someone who says I need to make this work... I think that is important.

Q. Anything else you feel the customer needs to be geared up for from your experience?

With this particular machine, as with all machines, the customers needs to be aware that there may be changes that are necessary to facilitate their particular cut goods or transportation of goods... that goes for every machine... every one is different. That's pretty much understood I think in the industry... this is an advanced prototype, it's a near production machine, we ought to try and get it with our stuff so we need to do that and we need to understand that there may be some changes necessary because we're different to the other guy... most people do understand that.

Q. What potential do you see for this machine at this stage? You've went through the development cycle, you have a couple of them in the market place, you're about to put a third machine globally out in the market place and it is interfaced with a new machine for the first time. Do you see further potential for this machine from a business perspective?

The total sale of the machine may go into the hundreds of thousands (dollars), which by our standards and what we've put into the development of it is not great... it is not big numbers. But when we started the project the quantities were in the hundreds that we needed to produce... the equation was changed.

Q. What do you think changed that equation?

The low cost of offshore manufacturing.

Q. External?

External.

Q. On reflection could that have been seen at the time?

I don't believe so. I don't believe that we could have predicted that... certainly not when we started the project.

Q. In terms of the actual model, how would you describe the technology at this stage in terms of its life cycle? Where exactly is it? How would you term where it's at at this moment in time?

I would term it as a production model. It's been tooled up to make multiple units.

Q. Do you feel that it's a proven technology?

All aspects of it are proven and if you take each individual segment of the machine and look at it, there is no new technology there... its all old technology clinging together. That in itself can create some problems. For instance the picking, which is important... the pickers have existed for 20 years... they have picked sleeves for the last ten probably. The bulk transfer system and the flighted conveyor system are nothing new; there were expired patents on doing that... it's 17 years old, 20 years old now. The pre aligning system is something other people use; it's common technology. The vacuum transfer system... maybe for this industry is something novel but that's all, and the zippy aligner...those are basically the five or six aspects of the machine that's very old. All those old technologies, trying to put them together into something new makes it difficult. Integrating them into a system is the hard part and making them all work together as if they were an orchestra.

Q. How long do you think will be required in the manufacturing test environment in order to enable the recipients of it to determine if it's successful or otherwise?

I think that the customers will need another machine in order to see that the fruits of the machine are as good as they think. With one machine, they'll get production of it but the customer needs to realise that when you put two of them together, the overall efficiency of the system decreases. If all the machines run at 95% efficiency which is pretty high, then the overall efficiency of the system is 95% x 95% x 95% x 95%, etc. which makes it fall down into the 70% efficiency range. What I'm saying is that the chain is only as strong as one of it's weakest links and when you put four automated systems together, that's quite a chain of stuff happening there and at given point in time... a link in that chain is bound to break. The goal for all of us is to take (I speak in terms of 2 or 3 machines (cause that's what I feel is necessary) those four pieces of equipment as close to 100% efficiency as possible and that's not an easy task. So you'll see that one machine works but they'll realise to really prove the system they'll need another machine.

Q. Are there any other general aspects to the project or specific aspects that we haven't covered in terms of the evolution of the machine or any other issues at this stage that you think are important?
No. I think that we covered the evolution of it pretty good and I think we got everything. Nothing to comes to mind real quick. ok.

APPENDIX G (iii)

Project Submission Form

Fruit of the Loom International Ltd
Manufacturing Technology Development
Project Submission Form

Project Details **Date:** ________

1. **What is the title of the project proposed?** **By:** C.Kelly

   Jet Sew 5044 Automatic Loader Project.

2. **Name of Project Manager:** Mark Baldrick

   Position in Company: Project Engineer, Sewing

3. **Is your project:**

   a product development? ☐

   a process development ? ☒

4. **Please give a short description of the project, outlining main objectives.**

   The acquisition of an automated machine for loading sleeves into the AAC 411 Hem & Close sleeve machines in the Automatic Sewing Department.

   The primary objective of this project is to further reduce costs in the manufacture of Tee Shirts by reducing the amount of direct labour required in the current process. Today the man/machine ratio is one-to-one and it is envisaged that this ratio could be increased to one operator per three or four machines, thus taking out significant costs when factored up for the three-shift operation. Also, the highly repetitive loading operation would be eliminated along with the associated repetitive strain injury (RSI) risk which exists today.

5. **How long do you expect the project to take?**

   (Include scheduled start and finish dates)

   Approx One Year Start - June 1997, End – June 1998

6. List of Summary Tasks and possible Project Milestones (Include Gantt Chart)

Machine Options Analysis

Preliminary Design & Specification

Initial Cost/Benefit Analysis

Visit Supplier Company

Detailed Project Plan

Financial Review

Project Team Briefing/ Kick-off

Machine Delivery & Installation

Mechanic & Operator Training

Trial Period in Production

Project Reporting

Data Collection & Analysis – Industrial Engineering

Monthly Review Meetings

Final Report & Decision

7. Resources and area of technical expertise

Name	Area
Catriona Kelly	Manufacturing Technology Dev Manager
Mark Baldrick	Project Engineer, Sewing
Joe Mullan	Operations Manager, Sewing
Mickey Donaghey	Supervisor, Automatics Department
Sammy Wilson	Head Mechanic, Automatics Department
Owen Doherty	Sewing Mechanic, Automatics Department
TBC	Loader Machine Operator
TBC	Quality Engineer
TBC	Jet Sew Technician
Robert Beasock	Jet Sew Programme Manager
Ernst Schramayr	President, Jet Sew

Product/Process Development

8. What technological innovation would it contain for the company?

Automation of a manual loading & sewing operation

9. Degree of Technical Risk

Success Probability = 75%

Failure Probability = 25%

Note: Risk was originally 60% Failure when first submitted but trails in FTL U.S and Bassett-Walker meant that project engineer changed risk assessment factor based on discussions with these plants and Jet Sew.

10. How would it improve the marketability of products?

Reduced costs and greater margins; improved and more consistent quality of sleeve produced.

11. Other benefits/Constraining Factors e.g. Environmental Issues, Social

Eliminate mundane and highly repetitive manual sleeve loading operation; also, no repitive strain injury risk and associated insurance claim risk.

12. Universities/Technical Consultants and their role. Please give details.

Jet Sew Technologies personnel

13. Will development have patenting potential? If so, give estimates of return through commercial exploitation.

None

Project Costs

Details of Project Costs

14. Cost

			Amount (£)
(i)	**Labour**		
	(a) Management		£12,324
	(b) Supervisory		£9,958
	(c) Technical		£38,199
	(d) Factory	Directs	£18,983
		Indirects	£5,788
(ii)	Overhead contribution		£9,000
(iii)	Technical consultancy		
(iv)	Design consultancy		
(v)	Sub-contracting charges		
(vi)	Sub-contracting charges outside ROI		
(vii)	Equipment/Capex		£22,222
(viii)	Materials		£1,000
(ix)	Licence or Patent Costs		
(x)	Travel and subsistence		£4,500
(xi)	Trials and testing		£2,000
(xii)	Other		£10,000
	Gross Total		£133,974

15. Profile of expected expenditure by financial year

Year	1	2	
Amount	£53,590	£80,384	

Project Costs (contd.)

Cost Benefit Analysis

16. Total Project Cost £133,974 (Capital = £22,222 per machine)

17. Estimated Savings

Show basis for savings;

Based on one operator per 3 machines, thus saving 2 direct operators; also, reduce indirect labour for materials handling by one person per three machines. Payback on Capex only.

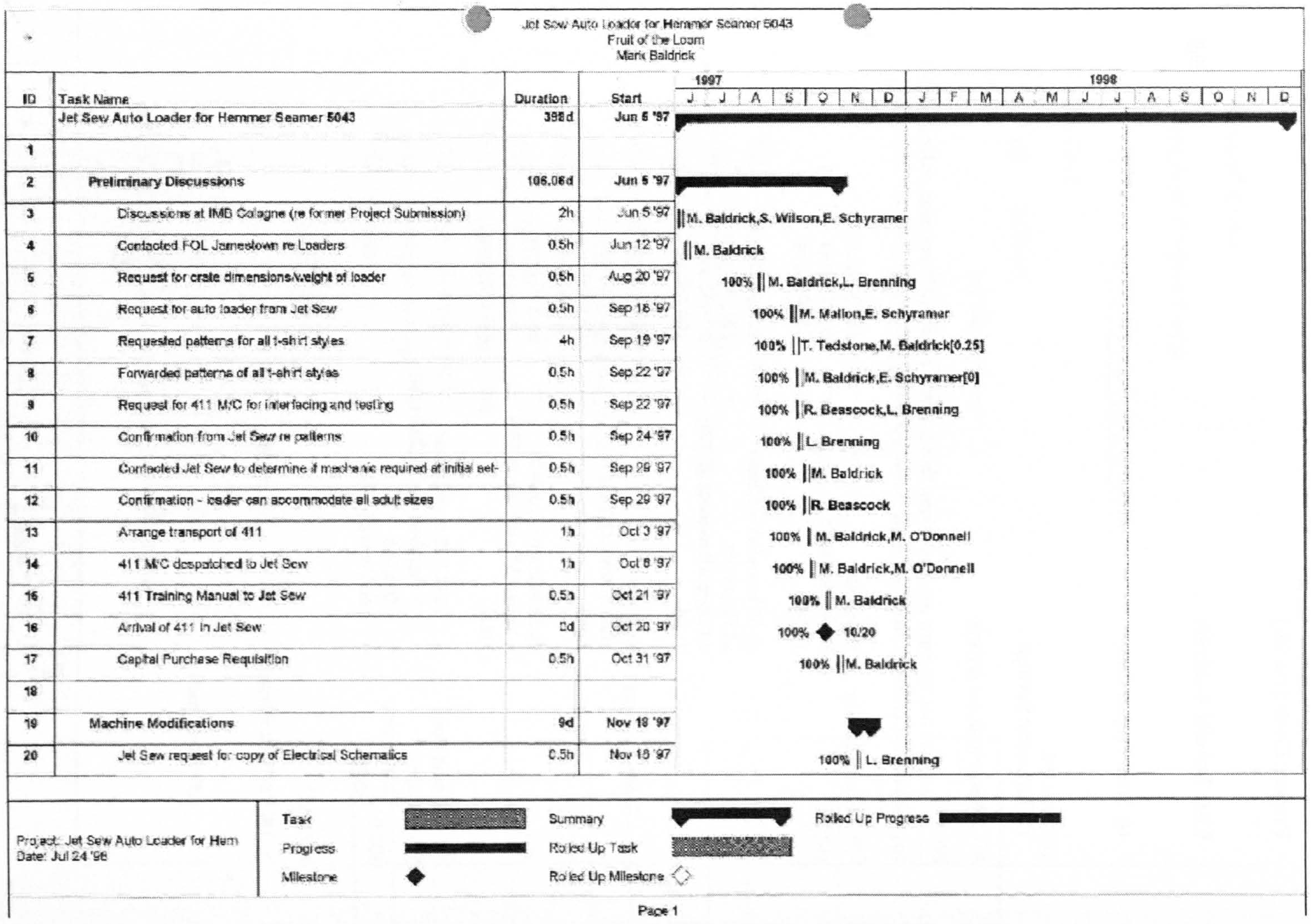
Direct Labour	Base Rate	=	£4.333/hour
	Shift Allowance	=	£0.916/hour
	Total	=	£5.249/hour
	@ 39 hours/wk x 52wks	=	£10,645 /year
	x2 Operators	=	£21,290/year
	x Fringe Allowances @ 35%	=	£7,452/year
	Total	=	£28,742/year
Indirect Labour	Base Rate	=	£3.960/hour
	Shift Allowance	=	£0.916/hour
	Total	=	£4 876/hour
	@ 39 hours/wk x 52wks	=	£9,889 /year
	x Fringe Allowances @ 35%	=	£3,461/year
	Total	=	£13,350/year

Grand Total = £42,092 savings/year
Capex = 3 machines @ £22,222 each
Total Capex = £66,666
Payback = £66,666/£42,092

18. Payback Period: 1.58 years

AFE Required: Yes ☒ No ☐ NPV ☐ DCF ☐ IRR ☐

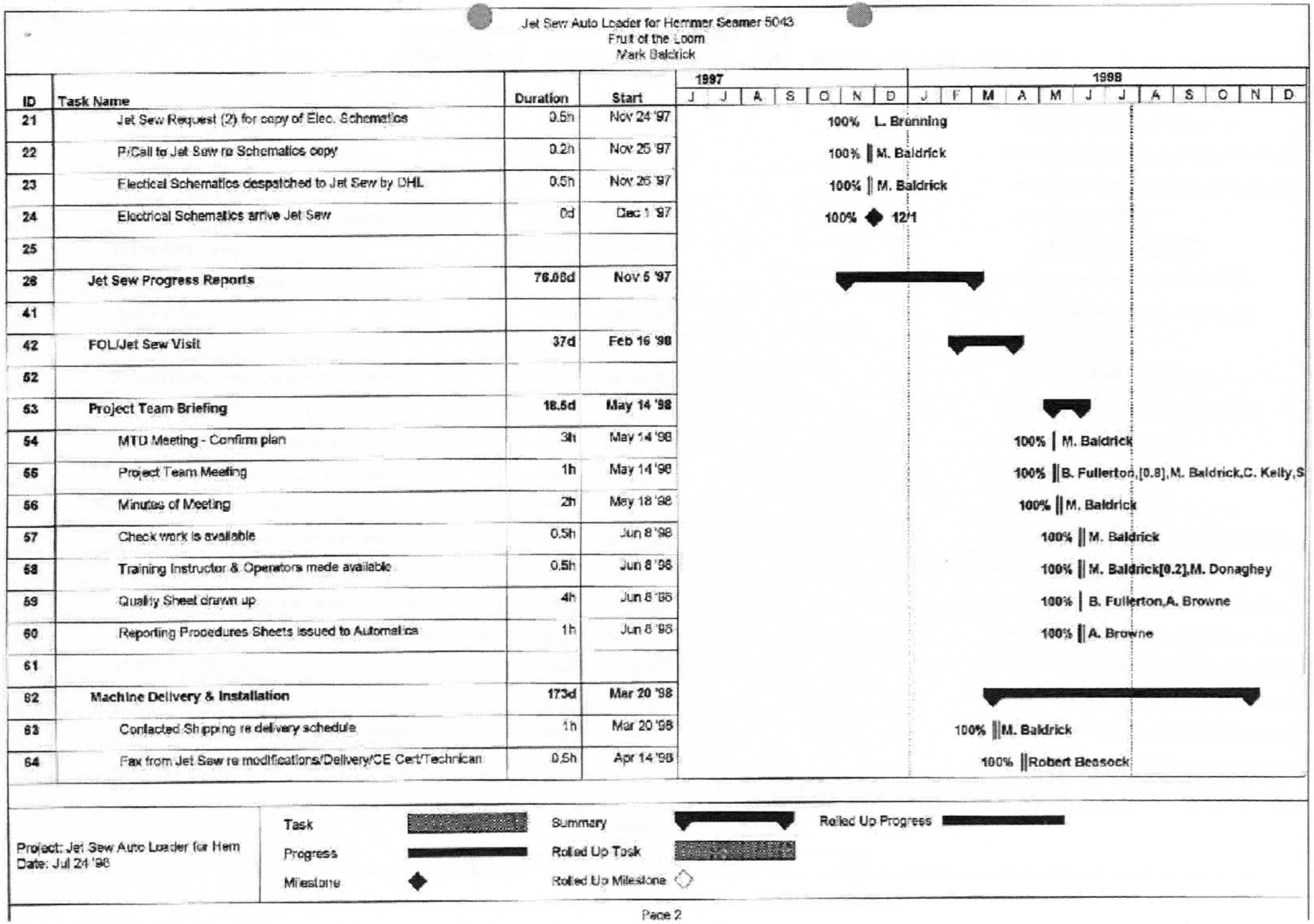
APPENDIX G (iv) Project Gantt Chart



Jet Sew Auto Loader for Hemmer Seamer 5043
Fruit of the Loom
Mark Baldrick

ID	Task Name	Duration	Start	
	Jet Sew Auto Loader for Hemmer Seamer 5043	**398d**	**Jun 5 '97**	
1				
2	**Preliminary Discussions**	**106.06d**	**Jun 5 '97**	
3	Discussions at IMB Cologne (re former Project Submission)	2h	Jun 5 '97	M. Baldrick,S. Wilson,E. Schyramer
4	Contacted FOL Jamestown re Loaders	0.5h	Jun 12 '97	M. Baldrick
5	Request for crate dimensions/weight of loader	0.5h	Aug 20 '97	100% M. Baldrick,L. Brenning
6	Request for auto loader from Jet Sew	0.5h	Sep 18 '97	100% M. Mallon,E. Schyramer
7	Requested patterns for all t-shirt styles	4h	Sep 19 '97	100% T. Tedstone,M. Baldrick[0.25]
8	Forwarded patterns of all t-shirt styles	0.5h	Sep 22 '97	100% M. Baldrick,E. Schyramer[0]
9	Request for 411 M/C for interfacing and testing	0.5h	Sep 22 '97	100% R. Beascock,L. Brenning
10	Confirmation from Jet Sew re patterns	0.5h	Sep 24 '97	100% L. Brenning
11	Contacted Jet Sew to determine if mechanic required at initial set-	0.5h	Sep 29 '97	100% M. Baldrick
12	Confirmation - loader can accommodate all adult sizes	0.5h	Sep 29 '97	100% R. Beascock
13	Arrange transport of 411	1h	Oct 3 '97	100% M. Baldrick,M. O'Donnell
14	411 M/C despatched to Jet Sew	1h	Oct 8 '97	100% M. Baldrick,M. O'Donnell
15	411 Training Manual to Jet Sew	0.5h	Oct 21 '97	100% M. Baldrick
16	Arrival of 411 in Jet Sew	0d	Oct 20 '97	100% ◆ 10/20
17	Capital Purchase Requisition	0.5h	Oct 31 '97	100% M. Baldrick
18				
19	**Machine Modifications**	**9d**	**Nov 18 '97**	
20	Jet Sew request for copy of Electrical Schematics	0.5h	Nov 18 '97	100% L. Brenning

Project: Jet Sew Auto Loader for Hem
Date: Jul 24 '98



Jet Sew Auto Loader for Hemmer Seamer 5043
Fruit of the Loom
Mark Baldrick

ID	Task Name	Duration	Start
21	Jet Sew Request (2) for copy of Elec. Schematics	0.5h	Nov 24 '97
22	P/Call to Jet Sew re Schematics copy	0.2h	Nov 25 '97
23	Electical Schematics despatched to Jet Sew by DHL	0.5h	Nov 26 '97
24	Electrical Schematics arrive Jet Sew	0d	Dec 1 '97
25			
26	**Jet Sew Progress Reports**	**76.08d**	**Nov 5 '97**
41			
42	**FOL/Jet Sew Visit**	**37d**	**Feb 16 '98**
52			
53	**Project Team Briefing**	**18.5d**	**May 14 '98**
54	MTD Meeting - Confirm plan	3h	May 14 '98
55	Project Team Meeting	1h	May 14 '98
56	Minutes of Meeting	2h	May 18 '98
57	Check work is available	0.5h	Jun 8 '98
58	Training Instructor & Operators made available	0.5h	Jun 8 '98
59	Quality Sheet drawn up	4h	Jun 8 '98
60	Reporting Procedures Sheets issued to Automatics	1h	Jun 8 '98
61			
62	**Machine Delivery & Installation**	**173d**	**Mar 20 '98**
63	Contacted Shipping re delivery schedule	1h	Mar 20 '98
64	Fax from Jet Sew re modifications/Delivery/CE Cert/Technican	0.5h	Apr 14 '98

Project: Jet Sew Auto Loader for Hem
Date: Jul 24 '98

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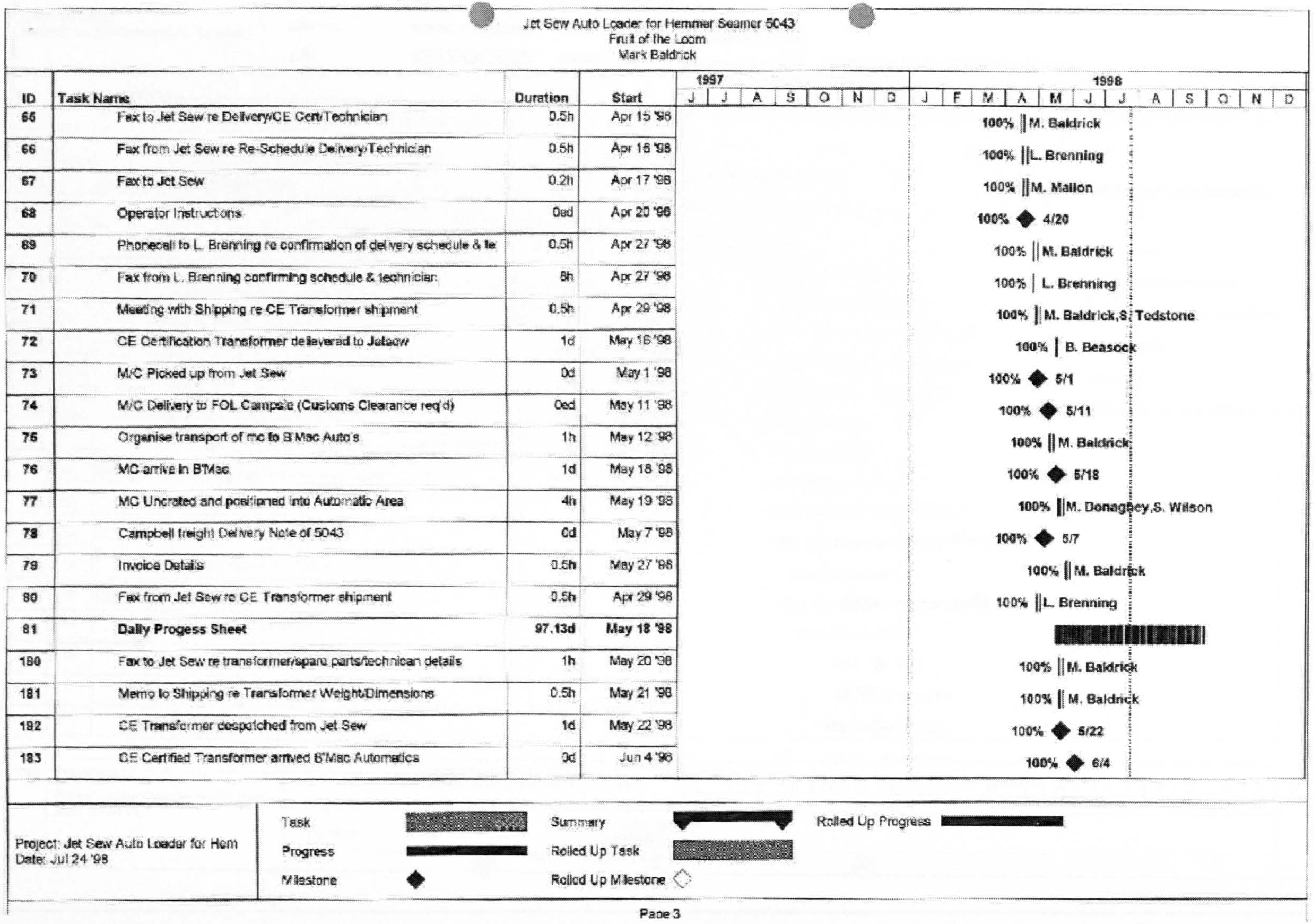

Jet Sew Auto Loader for Hemmer Seamer 5043
Fruit of the Loom
Mark Baldrick

ID	Task Name	Duration	Start
65	Fax to Jet Sew re Delivery/CE Cert/Technician	0.5h	Apr 15 '98
66	Fax from Jet Sew re Re-Schedule Delivery/Technician	0.5h	Apr 16 '98
67	Fax to Jet Sew	0.2h	Apr 17 '98
68	Operator Instructions	0ed	Apr 20 '98
69	Phonecall to L. Brenning re confirmation of delivery schedule & te	0.5h	Apr 27 '98
70	Fax from L. Brenning confirming schedule & technician	8h	Apr 27 '98
71	Meeting with Shipping re CE Transformer shipment	0.5h	Apr 29 '98
72	CE Certification Transformer delieverad to Jetsew	1d	May 16 '98
73	M/C Picked up from Jet Sew	0d	May 1 '98
74	M/C Delivery to FOL Campsie (Customs Clearance req'd)	0ed	May 11 '98
75	Organise transport of mc to B'Mac Auto's	1h	May 12 '98
76	MC arrive in B'Mac	1d	May 18 '98
77	MC Uncrated and positioned into Automatic Area	4h	May 19 '98
78	Campbell freight Delivery Note of 5043	0d	May 7 '98
79	Invoice Details	0.5h	May 27 '98
80	Fax from Jet Sew re CE Transformer shipment	0.5h	Apr 29 '98
81	**Daily Progess Sheet**	**97.13d**	**May 18 '98**
180	Fax to Jet Sew re transformer/spare parts/technican details	1h	May 20 '98
181	Memo to Shipping re Transformer Weight/Dimensions	0.5h	May 21 '98
182	CE Transformer despatched from Jet Sew	1d	May 22 '98
183	CE Certified Transformer arrived B'Mac Automatics	0d	Jun 4 '98

Project: Jet Sew Auto Loader for Hem
Date: Jul 24 '98

Task	▨	Summary	▬	Rolled Up Progress	▬
Progress	▬	Rolled Up Task	▨		
Milestone	◆	Rolled Up Milestone	◇		

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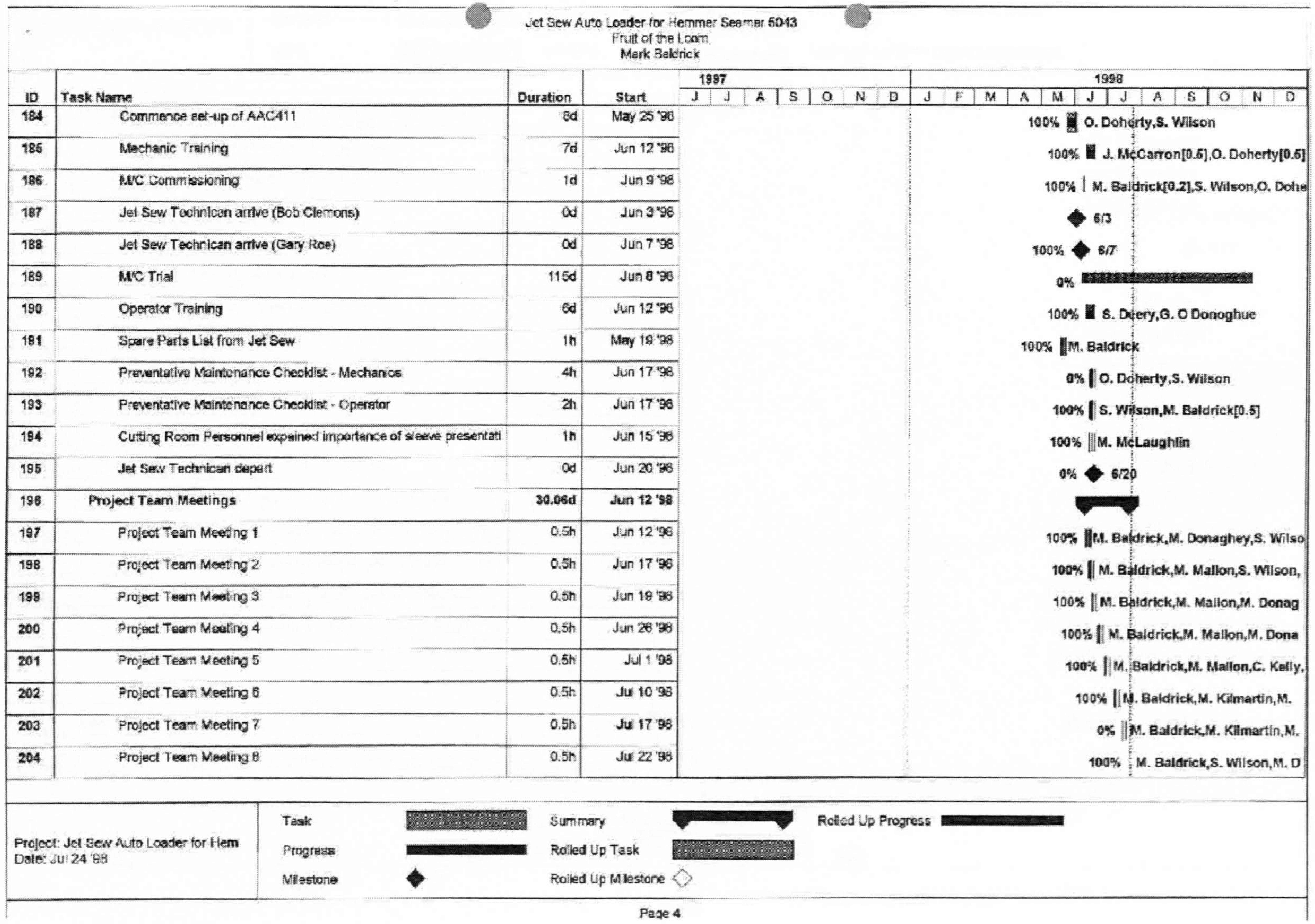

Jet Sew Auto Loader for Hemmer Seamer 5043
Fruit of the Loom
Mark Baldrick

ID	Task Name	Duration	Start	1997 J J A S O N D – 1998 J F M A M J J A S O N D
184	Commence set-up of AAC411	8d	May 25 '98	100% O. Doherty,S. Wilson
185	Mechanic Training	7d	Jun 12 '98	100% J. McCarron[0.5],O. Doherty[0.5]
186	M/C Commissioning	1d	Jun 9 '98	100% M. Baldrick[0.2],S. Wilson,O. Dohe
187	Jet Sew Technican arrive (Bob Clemons)	0d	Jun 3 '98	◆ 6/3
188	Jet Sew Technican arrive (Gary Roe)	0d	Jun 7 '98	100% ◆ 6/7
189	M/C Trial	115d	Jun 8 '98	0%
190	Operator Training	6d	Jun 12 '98	100% S. Deery,G. O Donoghue
191	Spare Parts List from Jet Sew	1h	May 19 '98	100% M. Baldrick
192	Preventative Maintenance Checklist - Mechanics	4h	Jun 17 '98	0% O. Doherty,S. Wilson
193	Preventative Maintenance Checklist - Operator	2h	Jun 17 '98	100% S. Wilson,M. Baldrick[0.5]
194	Cutting Room Personnel expained importance of sleeve presentati	1h	Jun 15 '98	100% M. McLaughlin
195	Jet Sew Technican depart	0d	Jun 20 '98	0% ◆ 6/20
196	**Project Team Meetings**	**30.06d**	**Jun 12 '98**	
197	Project Team Meeting 1	0.5h	Jun 12 '98	100% M. Baldrick,M. Donaghey,S. Wilso
198	Project Team Meeting 2	0.5h	Jun 17 '98	100% M. Baldrick,M. Mallon,S. Wilson,
199	Project Team Meeting 3	0.5h	Jun 19 '98	100% M. Baldrick,M. Mallon,M. Donag
200	Project Team Meeting 4	0.5h	Jun 26 '98	100% M. Baldrick,M. Mallon,M. Dona
201	Project Team Meeting 5	0.5h	Jul 1 '98	100% M. Baldrick,M. Mallon,C. Kelly,
202	Project Team Meeting 6	0.5h	Jul 10 '98	100% M. Baldrick,M. Kilmartin,M.
203	Project Team Meeting 7	0.5h	Jul 17 '98	0% M. Baldrick,M. Kilmartin,M.
204	Project Team Meeting 8	0.5h	Jul 22 '98	100% M. Baldrick,S. Wilson,M. D

Project: Jet Sew Auto Loader for Hem
Date: Jul 24 '98

Task	▨	Summary	▬	Rolled Up Progress	▬
Progress	▬	Rolled Up Task	▨		
Milestone	◆	Rolled Up Milestone	◇		

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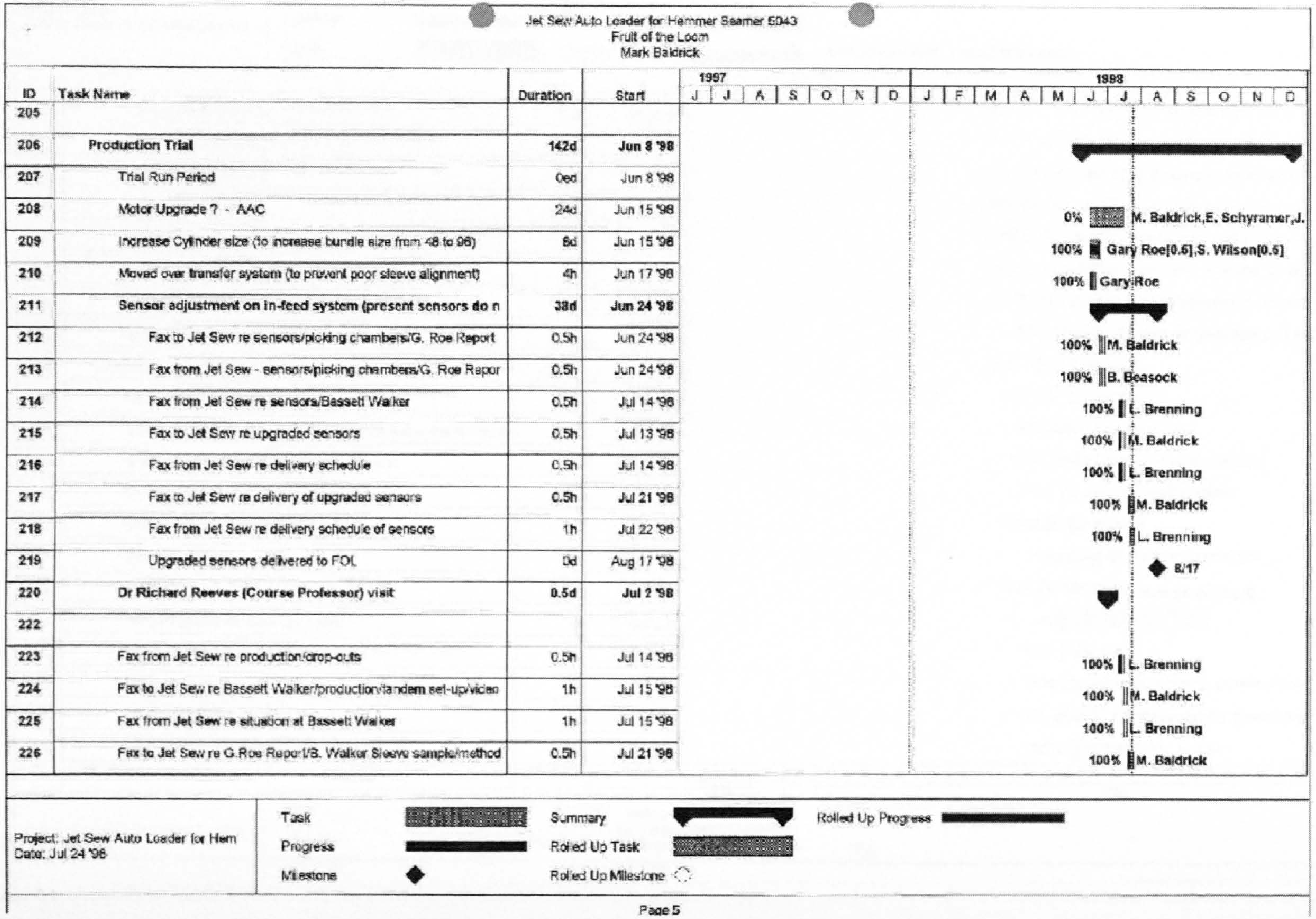

Jet Sew Auto Loader for Hemmer Seamer 5043
Fruit of the Loom
Mark Baldrick

ID	Task Name	Duration	Start
205			
206	**Production Trial**	**142d**	**Jun 8 '98**
207	Trial Run Period	0ed	Jun 8 '98
208	Motor Upgrade ? - AAC	24d	Jun 15 '98
209	Increase Cylinder size (to increase bundle size from 48 to 96)	8d	Jun 15 '98
210	Moved over transfer system (to prevent poor sleeve alignment)	4h	Jun 17 '98
211	**Sensor adjustment on in-feed system (present sensors do n**	**38d**	**Jun 24 '98**
212	Fax to Jet Sew re sensors/picking chambers/G. Roe Report	0.5h	Jun 24 '98
213	Fax from Jet Sew - sensors/picking chambers/G. Roe Repor	0.5h	Jun 24 '98
214	Fax from Jet Sew re sensors/Bassett Walker	0.5h	Jul 14 '98
215	Fax to Jet Sew re upgraded sensors	0.5h	Jul 13 '98
216	Fax from Jet Sew re delivery schedule	0.5h	Jul 14 '98
217	Fax to Jet Sew re delivery of upgraded sensors	0.5h	Jul 21 '98
218	Fax from Jet Sew re delivery schedule of sensors	1h	Jul 22 '98
219	Upgraded sensors delivered to FOL	0d	Aug 17 '98
220	**Dr Richard Reeves (Course Professor) visit**	**0.5d**	**Jul 2 '98**
222			
223	Fax from Jet Sew re production/drop-outs	0.5h	Jul 14 '98
224	Fax to Jet Sew re Bassett Walker/production/tandem set-up/video	1h	Jul 15 '98
225	Fax from Jet Sew re situation at Bassett Walker	1h	Jul 15 '98
226	Fax to Jet Sew re G.Roe Report/B. Walker Sleeve sample/method	0.5h	Jul 21 '98

Project: Jet Sew Auto Loader for Hem
Date: Jul 24 '98

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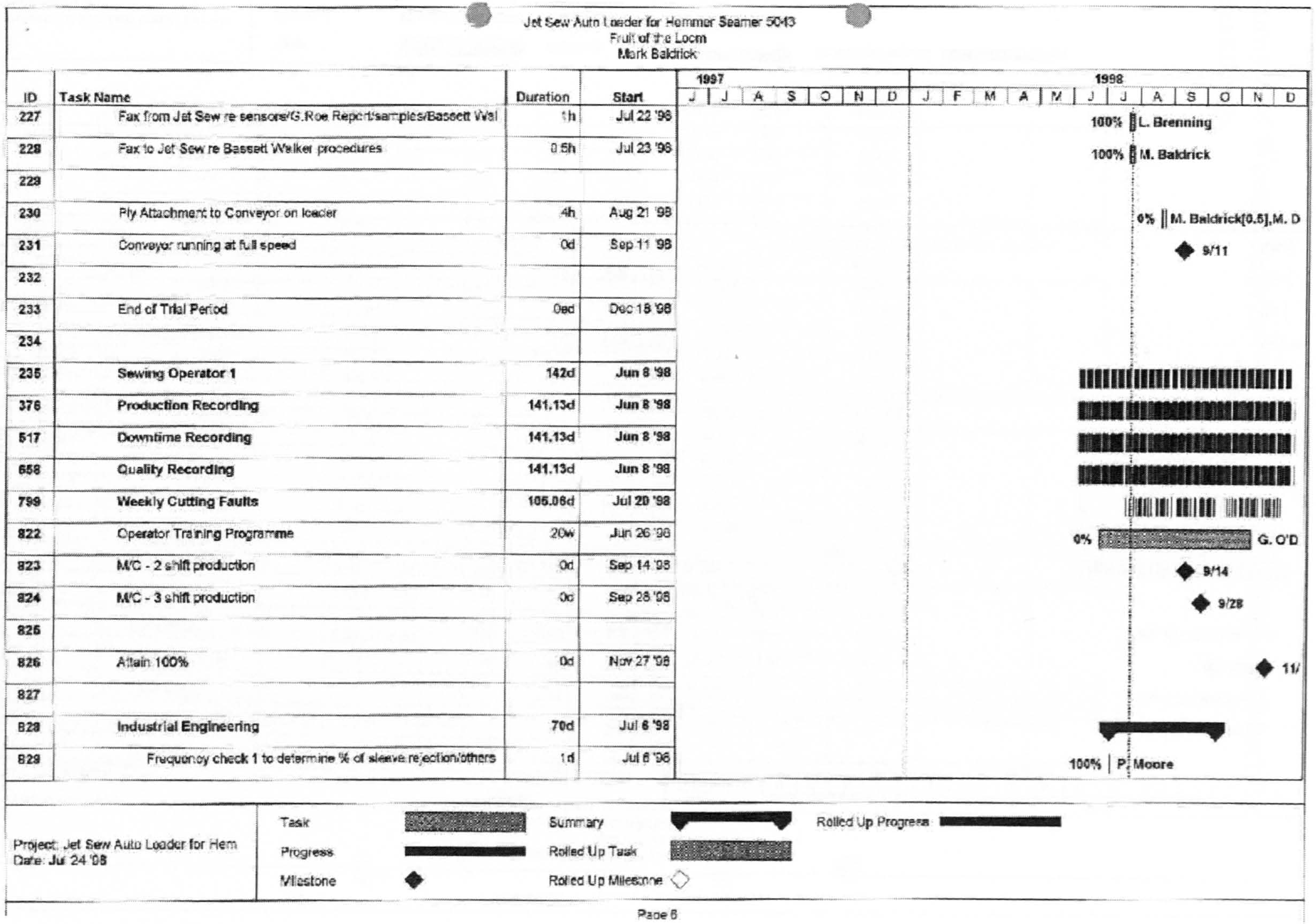

Jet Sew Auto Loader for Hemmer Seamer 5043
Fruit of the Loom
Mark Baldrick

ID	Task Name	Duration	Start
227	Fax from Jet Sew re sensors/G.Roe Report/samples/Bassett Wal	1h	Jul 22 '98
228	Fax to Jet Sew re Bassett Walker procedures	0.5h	Jul 23 '98
229			
230	Ply Attachment to Conveyor on loader	4h	Aug 21 '98
231	Conveyor running at full speed	0d	Sep 11 '98
232			
233	End of Trial Period	0ed	Dec 18 '98
234			
235	**Sewing Operator 1**	**142d**	**Jun 8 '98**
376	**Production Recording**	**141.13d**	**Jun 8 '98**
517	**Downtime Recording**	**141.13d**	**Jun 8 '98**
658	**Quality Recording**	**141.13d**	**Jun 8 '98**
799	**Weekly Cutting Faults**	**105.06d**	**Jul 20 '98**
822	Operator Training Programme	20w	Jun 26 '98
823	M/C - 2 shift production	0d	Sep 14 '98
824	M/C - 3 shift production	0d	Sep 28 '98
825			
826	Attain 100%	0d	Nov 27 '98
827			
828	**Industrial Engineering**	**70d**	**Jul 6 '98**
829	Frequency check 1 to determine % of sleeve rejection/others	1d	Jul 6 '98

Project: Jet Sew Auto Loader for Hem
Date: Jul 24 '98

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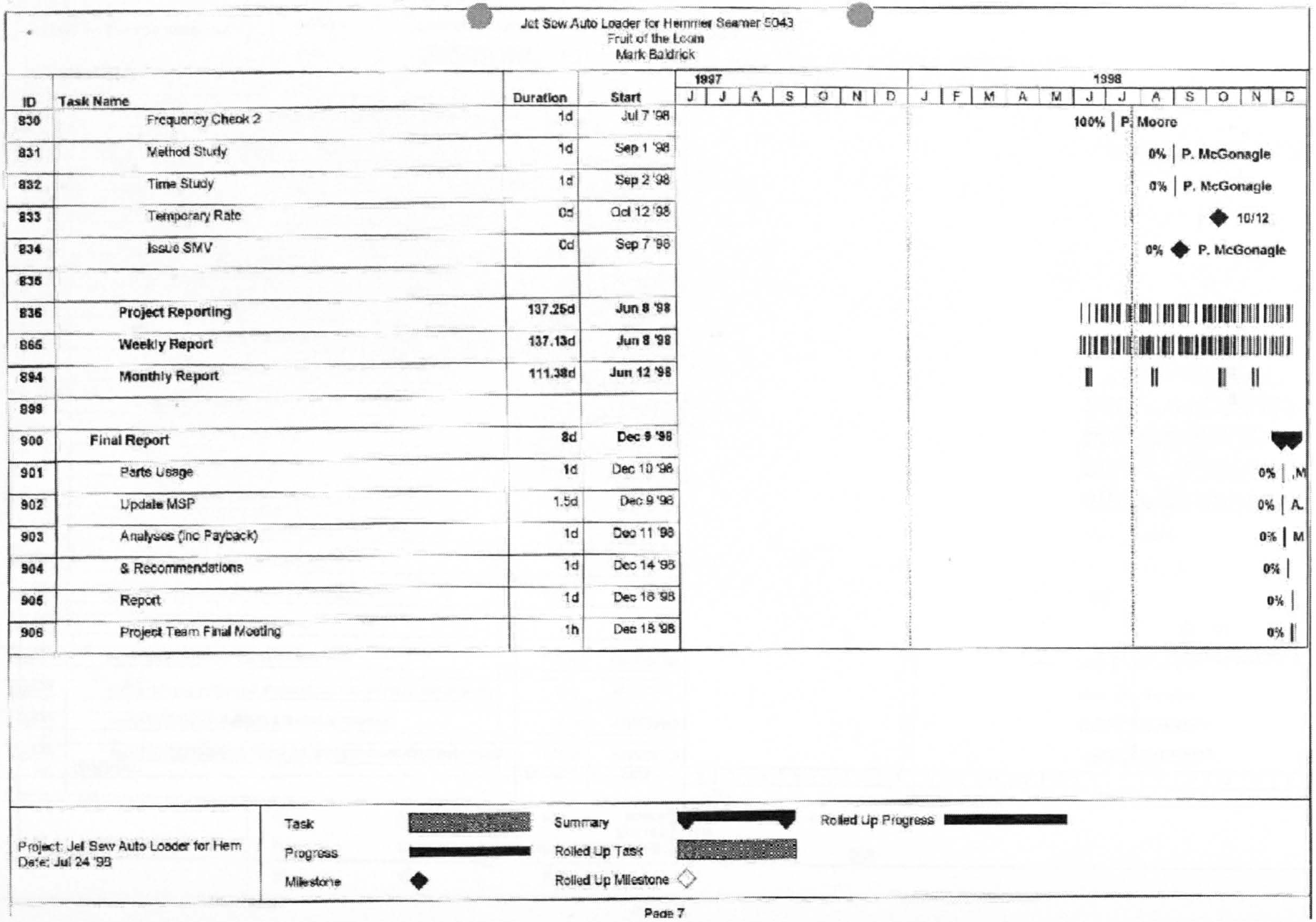

Jet Sew Auto Loader for Hemmer Seamer 5043
Fruit of the Loom
Mark Baldrick

ID	Task Name	Duration	Start
830	Frequency Check 2	1d	Jul 7 '98
831	Method Study	1d	Sep 1 '98
832	Time Study	1d	Sep 2 '98
833	Temporary Rate	0d	Oct 12 '98
834	Issue SMV	0d	Sep 7 '98
835			
836	**Project Reporting**	**137.25d**	**Jun 8 '98**
865	**Weekly Report**	**137.13d**	**Jun 8 '98**
894	**Monthly Report**	**111.38d**	**Jun 12 '98**
899			
900	**Final Report**	**8d**	**Dec 9 '98**
901	Parts Usage	1d	Dec 10 '98
902	Update MSP	1.5d	Dec 9 '98
903	Analyses (inc Payback)	1d	Dec 11 '98
904	& Recommendations	1d	Dec 14 '98
905	Report	1d	Dec 18 '98
906	Project Team Final Meeting	1h	Dec 18 '98

Project: Jet Sew Auto Loader for Hem
Date: Jul 24 '98

Task	▨	Summary		Rolled Up Progress	■
Progress	■	Rolled Up Task	▨		
Milestone	◆	Rolled Up Milestone	◇		

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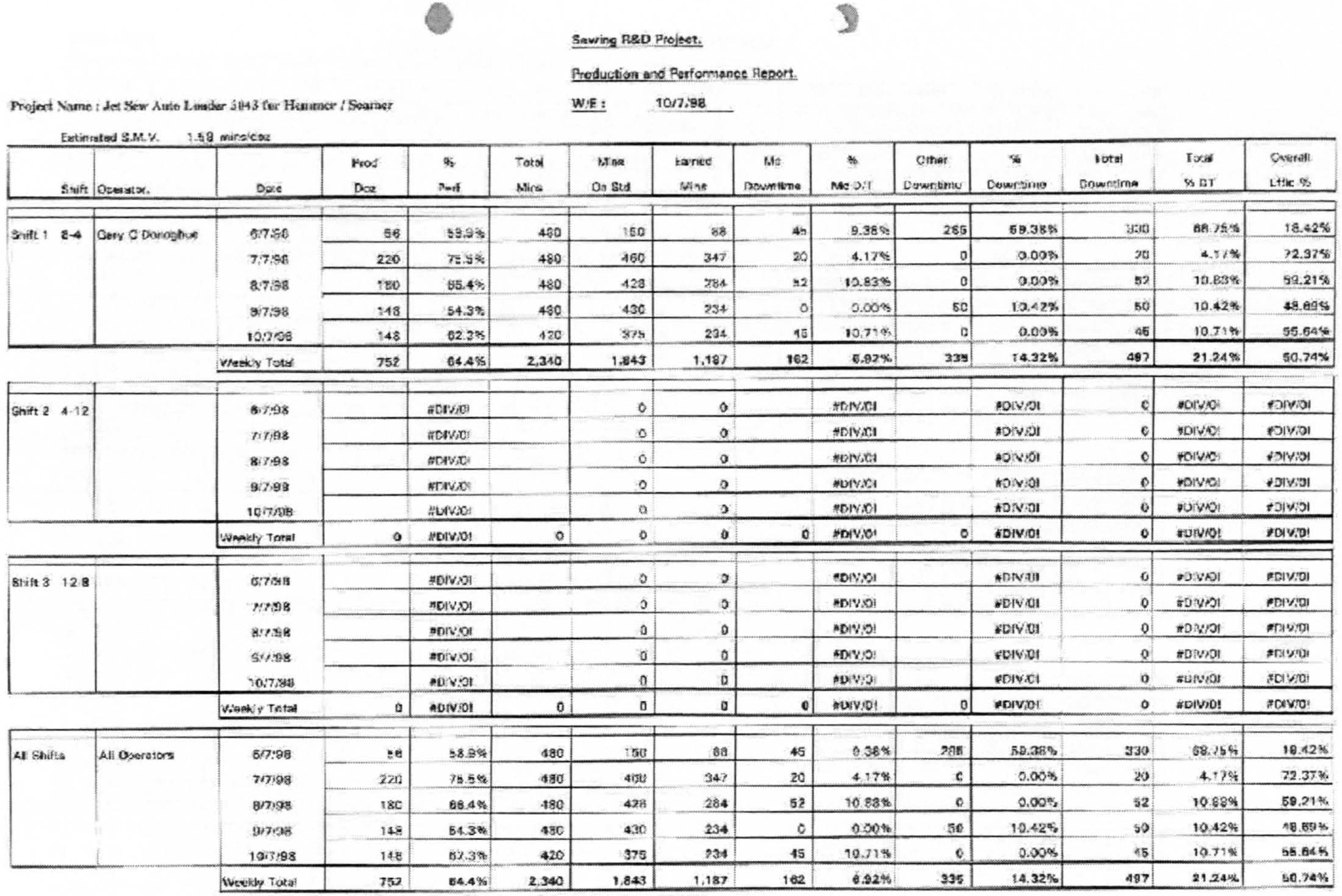
APPENDIX G (v)

Example of Weekly Reports – Production, Quality and Machine Breakdown.



Sewing R&D Project.

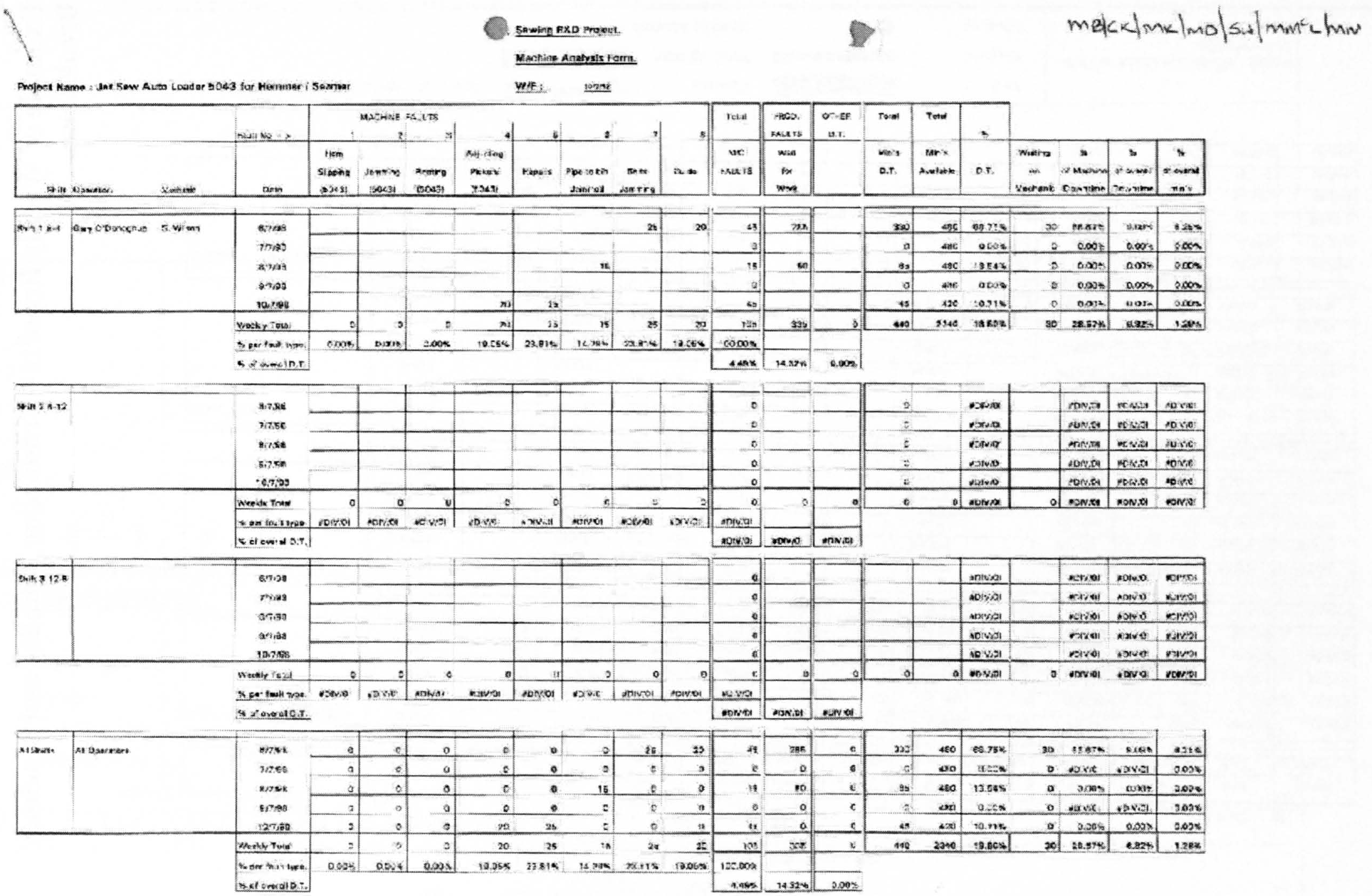
Production and Performance Report.

Project Name : Jet Sew Auto Loader 5843 for Hammer / Seamer

W/E : 10/7/98

Estimated S.M.V. 1.58 mins/doz

Shift	Operator.	Date	Prod Doz	% Perf	Total Mins	Mins On Std	Earned Mins	Mc Downtime	% Mc D/T	Other Downtime	% Downtime	Total Downtime	Total % DT	Overall Effic %
Shift 1 8-4	Gary C Donoghue	6/7/98	56	58.9%	480	150	88	45	9.38%	285	59.38%	330	68.75%	18.42%
		7/7/98	220	75.5%	480	460	347	20	4.17%	0	0.00%	20	4.17%	72.37%
		8/7/98	180	66.4%	480	428	284	52	10.83%	0	0.00%	52	10.83%	59.21%
		9/7/98	148	54.3%	480	430	234	0	0.00%	50	10.42%	50	10.42%	48.69%
		10/7/98	148	62.3%	420	375	234	45	10.71%	0	0.00%	45	10.71%	55.64%
		Weekly Total	752	64.4%	2,340	1,843	1,187	162	6.92%	335	14.32%	497	21.24%	50.74%
Shift 2 4-12		6/7/98		#DIV/0!		0	0		#DIV/0!		#DIV/0!	0	#DIV/0!	#DIV/0!
		7/7/98		#DIV/0!		0	0		#DIV/0!		#DIV/0!	0	#DIV/0!	#DIV/0!
		8/7/98		#DIV/0!		0	0		#DIV/0!		#DIV/0!	0	#DIV/0!	#DIV/0!
		9/7/98		#DIV/0!		0	0		#DIV/0!		#DIV/0!	0	#DIV/0!	#DIV/0!
		10/7/98		#DIV/0!		0	0		#DIV/0!		#DIV/0!	0	#DIV/0!	#DIV/0!
		Weekly Total	0	#DIV/0!	0	0	0	0	#DIV/0!	0	#DIV/0!	0	#DIV/0!	#DIV/0!
Shift 3 12-8		6/7/98		#DIV/0!		0	0		#DIV/0!		#DIV/0!	0	#DIV/0!	#DIV/0!
		7/7/98		#DIV/0!		0	0		#DIV/0!		#DIV/0!	0	#DIV/0!	#DIV/0!
		8/7/98		#DIV/0!		0	0		#DIV/0!		#DIV/0!	0	#DIV/0!	#DIV/0!
		9/7/98		#DIV/0!		0	0		#DIV/0!		#DIV/0!	0	#DIV/0!	#DIV/0!
		10/7/98		#DIV/0!		0	0		#DIV/0!		#DIV/0!	0	#DIV/0!	#DIV/0!
		Weekly Total	0	#DIV/0!	0	0	0	0	#DIV/0!	0	#DIV/0!	0	#DIV/0!	#DIV/0!
All Shifts	All Operators	6/7/98	56	58.9%	480	150	88	45	9.38%	285	59.38%	330	68.75%	18.42%
		7/7/98	220	75.5%	480	460	347	20	4.17%	0	0.00%	20	4.17%	72.37%
		8/7/98	180	66.4%	480	428	284	52	10.83%	0	0.00%	52	10.83%	59.21%
		9/7/98	148	54.3%	480	430	234	0	0.00%	50	10.42%	50	10.42%	48.69%
		10/7/98	148	62.3%	420	375	234	45	10.71%	0	0.00%	45	10.71%	55.64%
		Weekly Total	752	64.4%	2,340	1,843	1,187	162	6.92%	335	14.32%	497	21.24%	50.74%



me|ck|mk|mo|su|mmc|mw

Sewing R&D Project.

Machine Analysis Form.

Project Name : Jet Sew Auto Loader 5043 for Hemmer / Seamer

W/E : 10/7/98

			Fault No ->	MACHINE FAULTS 1	2	3	4	5	6	7	8	Total	PROD. FAULTS	OTHER D.T.	Total	Total	%				
Shift	Operator	Mechanic	Date	Hem Slipping (5043)	Jamming (5043)	Homing (5043)	Adjusting Pickers (5043)	Repairs	Pipe to bin Jamm'ed	Belts Jamming	Guide	M/C FAULTS	Wait for Work		Min's D.T.	Min's Available	D.T.	Waiting on Mechanic	% of Machine Downtime	% of overall Downtime	% of overall min's
Shift 1 8-4	Gary O'Donoghue	S. Wilson	6/7/98							25	20	45	285		330	480	68.75%	30	66.67%	9.09%	6.25%
			7/7/98									0			0	480	0.00%	0	0.00%	0.00%	0.00%
			8/7/98						15			15	50		65	480	13.54%	0	0.00%	0.00%	0.00%
			9/7/98									0			0	480	0.00%	0	0.00%	0.00%	0.00%
			10/7/98				20	25				45			45	420	10.71%	0	0.00%	0.00%	0.00%
			Weekly Total	0	0	0	20	25	15	25	20	105	335	0	440	2340	18.80%	30	28.57%	6.82%	1.28%
			% per fault type	0.00%	0.00%	0.00%	19.05%	23.81%	14.29%	23.81%	19.05%	100.00%									
			% of overall D.T.									4.49%	14.32%	0.00%							
Shift 2 4-12			6/7/98									0			0		#DIV/0!		#DIV/0!	#DIV/0!	#DIV/0!
			7/7/98									0			0		#DIV/0!		#DIV/0!	#DIV/0!	#DIV/0!
			8/7/98									0			0		#DIV/0!		#DIV/0!	#DIV/0!	#DIV/0!
			9/7/98									0			0		#DIV/0!		#DIV/0!	#DIV/0!	#DIV/0!
			10/7/98									0			0		#DIV/0!		#DIV/0!	#DIV/0!	#DIV/0!
			Weekly Total	0	0	0	0	0	0	0	0	0	0	0	0	0	#DIV/0!	0	#DIV/0!	#DIV/0!	#DIV/0!
			% per fault type	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!									
			% of overall D.T.									#DIV/0!	#DIV/0!	#DIV/0!							
Shift 3 12-8			6/7/98									0					#DIV/0!		#DIV/0!	#DIV/0!	#DIV/0!
			7/7/98									0					#DIV/0!		#DIV/0!	#DIV/0!	#DIV/0!
			8/7/98									0					#DIV/0!		#DIV/0!	#DIV/0!	#DIV/0!
			9/7/98									0					#DIV/0!		#DIV/0!	#DIV/0!	#DIV/0!
			10/7/98									0					#DIV/0!		#DIV/0!	#DIV/0!	#DIV/0!
			Weekly Total	0	0	0	0	0	0	0	0	0	0	0	0	0	#DIV/0!	0	#DIV/0!	#DIV/0!	#DIV/0!
			% per fault type	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!									
			% of overall D.T.									#DIV/0!	#DIV/0!	#DIV/0!							
All Shifts	All Operators		6/7/98	0	0	0	0	0	0	25	20	45	285	0	330	480	68.75%	30	66.67%	9.09%	6.25%
			7/7/98	0	0	0	0	0	0	0	0	0	0	0	0	480	0.00%	0	#DIV/0!	#DIV/0!	0.00%
			8/7/98	0	0	0	0	0	15	0	0	15	50	0	65	480	13.54%	0	0.00%	0.00%	0.00%
			9/7/98	0	0	0	0	0	0	0	0	0	0	0	0	480	0.00%	0	#DIV/0!	#DIV/0!	0.00%
			10/7/98	0	0	0	20	25	0	0	0	45	0	0	45	420	10.71%	0	0.00%	0.00%	0.00%
			Weekly Total	0	0	0	20	25	15	25	20	105	335	0	440	2340	18.80%	30	28.57%	6.82%	1.28%
			% per fault type	0.00%	0.00%	0.00%	19.05%	23.81%	14.29%	23.81%	19.05%	100.00%									
			% of overall D.T.									4.49%	14.32%	0.00%							

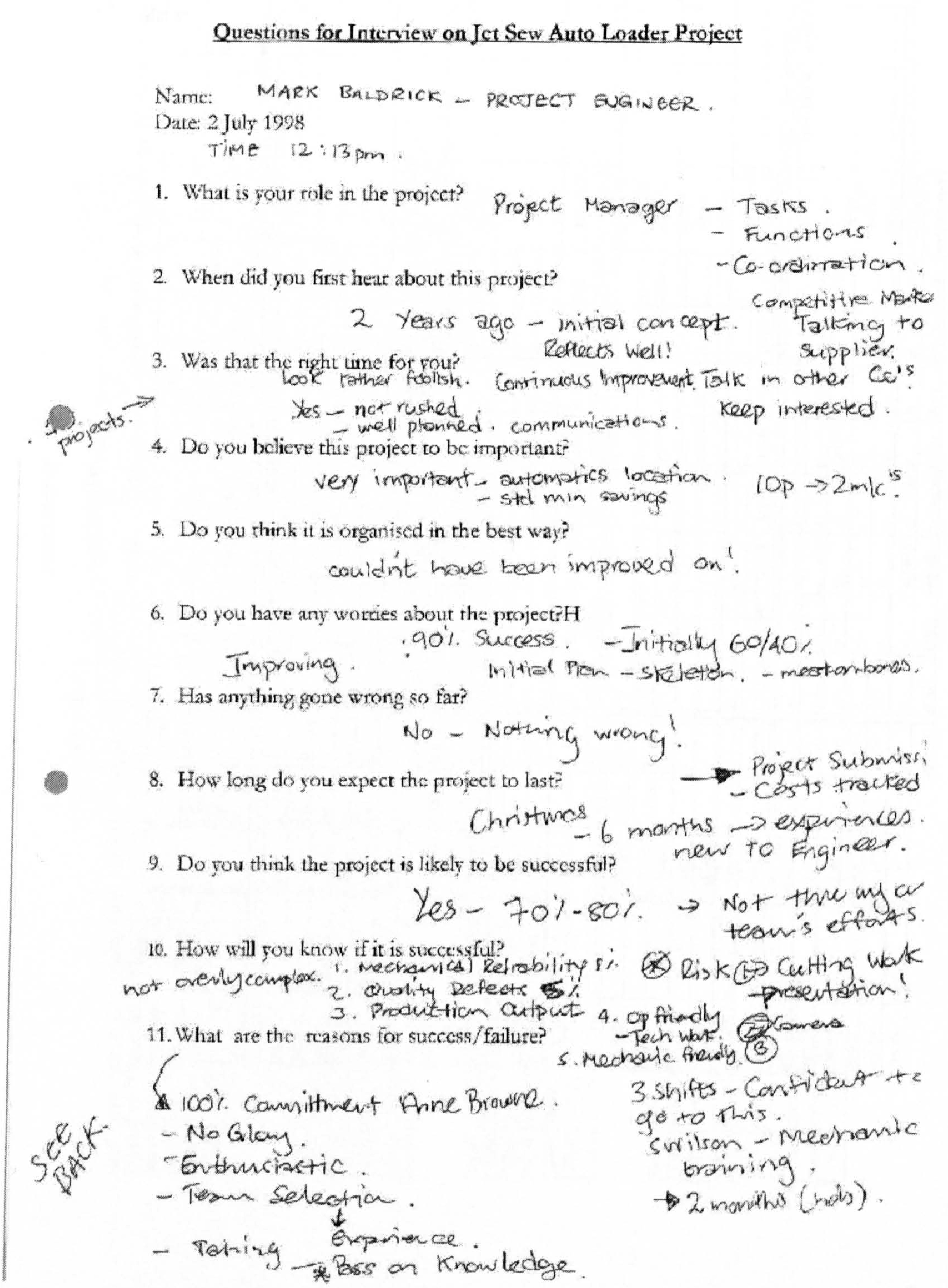
Sewing R&D Project.

Quality Analysis.

Project Name : Jet Sew Auto Loader 5843 for Hemmer / Seamer W/E : 10/7/98

			Leader								Total	Total		Total Doz	Sample
		Fault No =>	1	2	3	4	5	6	7	8	Faults	Doz Single	%	Production	%
Shif	Operator.	Date	Uneven Trim M/T 1/2"	Foldback	Inturn Out	Open Hem	Hem Fold	Pleats				Sleeves Examined		(Single Sleeves)	
Shift 8-4	Gary O'Donoghue	6/7/98	1	15		1	1	4			22	52	3.53%	112	46.43%
		7/7/98	6	15		13	4	4			42	220	1.59%	440	50.00%
		8/7/98	6	7		18	3	30			64	168	3.17%	360	46.67%
		9/7/98	13	14		14	2	52			85	162	5.21%	298	51.36%
		10/7/98	47	31		27	4	46			155	140	8.23%	296	47.30%
		Weekly Total	73	82	0	73	14	136	0	0	378	732	4.30%	1504	48.67%
		% per fault type	19.31%	21.69%	0.00%	19.31%	3.70%	35.98%	0.00%	0.00%	100.00%				
Shift 4-12		6/7/98									0		#DIV/0!		#DIV/0!
		7/7/98									0		#DIV/0!		#DIV/0!
		8/7/98									0		#DIV/0!		#DIV/0!
		9/7/98									0		#DIV/0!		#DIV/0!
		10/7/98									0		#DIV/0!		#DIV/0!
		Weekly Total	0	0	0	0	0	0	0	0	0	0	#DIV/0!	0	#DIV/0!
		% per fault type	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!				
Shift 12-8		6/7/98									0		#DIV/0!		#DIV/0!
		7/7/98									0		#DIV/0!		#DIV/0!
		8/7/98									0		#DIV/0!		#DIV/0!
		9/7/98									0		#DIV/0!		#DIV/0!
		10/7/98									0		#DIV/0!		#DIV/0!
		Weekly Total	0	0	0	0	0	0	0	0	0	0	#DIV/0!	0	#DIV/0!
		% per fault type	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!				
All Shifts	All Operators	6/7/98	1	15	0	1	1	4	0	0	22	52	3.53%	112	46.43%
		7/7/98	6	15	0	13	4	4	0	0	42	220	1.59%	440	50.00%
		8/7/98	6	7	0	18	3	30	0	0	64	168	3.17%	360	46.67%
		9/7/98	13	14	0	14	2	52	0	0	85	162	5.21%	298	51.36%
		10/7/98	47	31	0	27	4	46	0	0	155	140	8.23%	296	47.20%
		Weekly Total	73	82	0	73	14	136	0	0	378	732	4.30%	1504	48.67%
		% per fault type	19.31%	21.69%	0.00%	19.31%	3.70%	35.98%	0.00%	0.00%	100.00%				

APPENDIX G (vi) Example of Interview Sheet.



Questions for Interview on Jct Sew Auto Loader Project

Name: MARK BALDRICK – PROJECT ENGINEER.
Date: 2 July 1998
TIME 12:13pm.

1. What is your role in the project? Project Manager – Tasks.
– Functions.
– Co-ordination.

2. When did you first hear about this project?
2 Years ago – initial concept. Competitive Market Talking to Supplier.
Reflects Well!

3. Was that the right time for you?
look rather foolish. Continuous Improvement. Talk in other Co's.
Yes – not rushed.
– well planned. communications. Keep interested.
projects.

4. Do you believe this project to be important?
very important – automatics location.
– std min savings
10p → 2m/c's.

5. Do you think it is organised in the best way?
couldn't have been improved on!

6. Do you have any worries about the project?H
.90%. Success. – Initially 60/40%.
Improving. Initial Plan – skeleton. – meat on bones.

7. Has anything gone wrong so far?
No – Nothing wrong!

8. How long do you expect the project to last? → Project Submission
– Costs tracked
Christmas – 6 months → experiences.
new to Engineer.

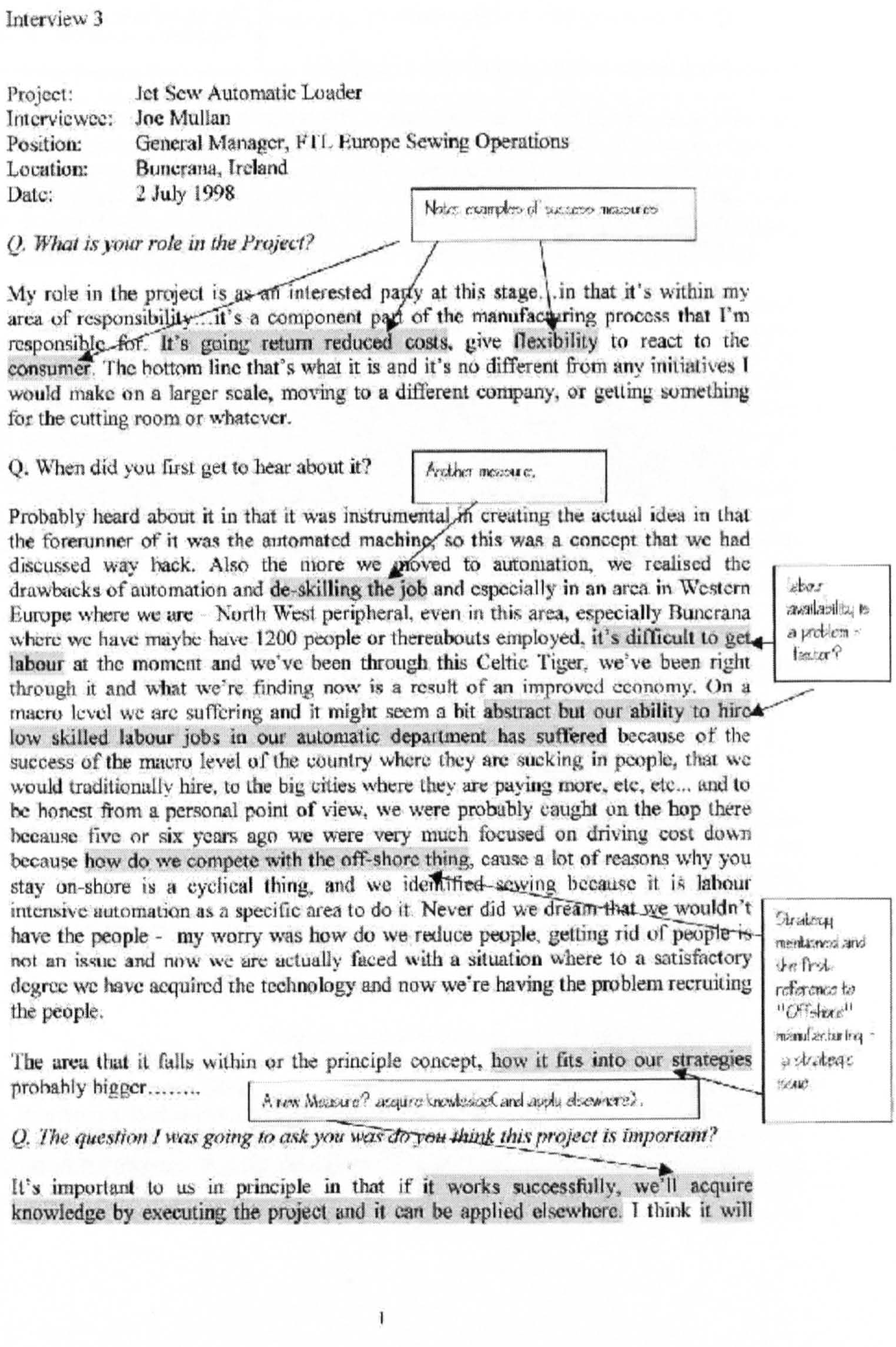
9. Do you think the project is likely to be successful?
Yes – 70%-80%. → Not through a team's efforts.

10. How will you know if it is successful?
not overly complex. 1. Mechanical Reliability %. ⊛ Risk ① → Cutting Work presentation!
2. Quality Defects 5%.
3. Production Output 4. Op friendly ② Camera
– Tech Wat.
5. Mechanic friendly. ③

11. What are the reasons for success/failure?
100% Commitment Anne Browne.
– No Glory.
– Enthusiastic.
– Team Selection.
↓
Experience.
– Taking – Pass on Knowledge.
3 Shifts – Confident to go to this.
S Wilson – Mechanic training.
→ 2 months (hols).

SEE BACK

APPENDIX G (vii) Example of Analysis of Interviews showing Clustering and Labeling.



Interview 3

Project: Jet Sew Automatic Loader
Interviewee: Joe Mullan
Position: General Manager, FTL Europe Sewing Operations
Location: Buncrana, Ireland
Date: 2 July 1998

Note: examples of success measures

Q. What is your role in the Project?

My role in the project is as an interested party at this stage...in that it's within my area of responsibility...it's a component part of the manufacturing process that I'm responsible for. It's going return reduced costs, give flexibility to react to the consumer. The bottom line that's what it is and it's no different from any initiatives I would make on a larger scale, moving to a different company, or getting something for the cutting room or whatever.

Q. When did you first get to hear about it?

Another measure.

Probably heard about it in that it was instrumental in creating the actual idea in that the forerunner of it was the automated machine, so this was a concept that we had discussed way back. Also the more we moved to automation, we realised the drawbacks of automation and de-skilling the job and especially in an area in Western Europe where we are - North West peripheral, even in this area, especially Buncrana where we have maybe have 1200 people or thereabouts employed, it's difficult to get labour at the moment and we've been through this Celtic Tiger, we've been right through it and what we're finding now is a result of an improved economy. On a macro level we are suffering and it might seem a bit abstract but our ability to hire low skilled labour jobs in our automatic department has suffered because of the success of the macro level of the country where they are sucking in people, that we would traditionally hire, to the big cities where they are paying more, etc, etc... and to be honest from a personal point of view, we were probably caught on the hop there because five or six years ago we were very much focused on driving cost down because how do we compete with the off-shore thing, cause a lot of reasons why you stay on-shore is a cyclical thing, and we identified sewing because it is labour intensive automation as a specific area to do it. Never did we dream that we wouldn't have the people - my worry was how do we reduce people, getting rid of people is not an issue and now we are actually faced with a situation where to a satisfactory degree we have acquired the technology and now we're having the problem recruiting the people.

labour availability is a problem - factor?

The area that it falls within or the principle concept, how it fits into our strategies probably bigger........

Strategy mentioned and the first reference to "Offshore" manufacturing - a strategic issue

A new Measure? acquire knowledge(and apply elsewhere).

Q. The question I was going to ask you was do you think this project is important?

It's important to us in principle in that if it works successfully, we'll acquire knowledge by executing the project and it can be applied elsewhere. I think it will certainly condition my outlook on the next five, seven years in that I can successfully defend a certain type of structured sewing base in Western Europe.

Q. It's got a very key strategic element?

Strategic conflict : defend Western Europe sewing base versus Off-Shore strategy

Yes it has, in principle and the way it's applied.

With the limited knowledge that I have of this particular project to date, because I had to approve it at this moment in time, with everything else that's going on, that we could proceed with this project, albeit that it was a project list approved in late 1997 and one of the reasons that I did do that was because I had known from our previous project management and the style that we do that in, it would be done effectively so it was common enough to let it go on.

Portfolio & EMP: limit risk by machine trial before "Replication"

Q. Do you have any worries about it?

Well again, the reason why I don't have any worries is prior to this even being on a list, we have a methodology which within it has built-in safety valves that I'm not going to go out and buy half a dozen of these machines when they are not working. So when I say I've been confident in that I don't feel, if it takes the project to be unsuccessful I know what I'm going to loose because in advance of that I have assessed that already. I do know from my past experience that this project, from a business perspective it cannot fail, because for me it will be a success if it fails in that I'll know from a strategic point of view that it's going to give me detailed information and knowledge either way. So I'm saying if it fails I'm glad I knew.

Strategy and direction under question

Q. So your perspective is very different from ours?

Well it's probably a wider one. Overall I have the desire that it's as successful as the other people interpret it from an operational point of view, because that gives me more options. But another area which would not be within their domain is the implications of the failure of it. If it fails for them, ok they may or may not have.... a lot of them who you have interviewed, it might actually pose a threat as to how we would conduct future sewing automation business in Ireland for them. Obviously it's a negative that people don't want to contemplate, but for whatever reason, if we can't sustain that department down there, if it can't add value to the business, it's not going to be there. It's probably something that they don't want to dwell upon because of the consequences.

Q. How long do you expect the project to last? Will it be on plan?

Yes, I would say, we're allowing this to go into early 1999 or there abouts.

Team Composition
Training
Machine Field-tested

Q. Do you think the project is likely to be successful?

I would have to relate back and say and for a monosyllabic answer, and say yes. The reason why I say that "yes" at a high level is that, I know Michael's comments very informally, I'm not kind of analysing the structure of the team and I know some of our technical people that went to train in the States, but I do know that this (machine) has been kind of field tested to a certain extent in other locations so I would have to say yes.

Q. How will you know if it is successful?

What I would have to say here Richard honestly, if you had of asked me that question prior to Michael embarking upon his research into what makes it, but I'm aware of that now, so the answer to that question is that I would get Michael to, I'm not biased, I'm informed, so what I will say is that I won't go down and look at the machine working and think that's great the machine is working, I will ask Michael, with his knowledge and match again a criteria which he has established through his work which we have paid and sponsored to tell me to what degree, if it comes through a group technical management assessment of what constitutes success, I'll accept it.

I've been through the interviews with Michael before so with hindsight it's great because I can answer and I'm much more comfortable to answer in certain ways, whereas before I could have went through this and said what's successful - well I'm going to look at the machine downtime and I'm getting into specifics, but yes all those things plus the other one hundred and something criteria that Michael has identified and I expect that all those things will be measured and I'll have a nice summary and also at that point in time, as we talked about the implications of strategy, at the end of the project when we're at 6 months, 12 months, we'll have to match the degrees of success on this or otherwise of the project against where we're at at that point in time. What are we doing in 1999 that may have implications from my perspective, bearing in mind we've done this for all the reasons, and that's it and we think that's good and the reason why there is a Western European dimension, there's an off-shore, there's a cost, quality, etc. etc. I go to Ethiopia and I think successfully I can turn the whole T-Shirt construction back to manual and for the next five years, because my corporate body has told me don't look any further than five years, probability is I can reverse everything we've done in the last five years, then it won't be successful because I've changed the goal posts.

Project management
Resource base
(Team Composition)

Q. What are the reasons for success?

In the context of operating on the factory floor so to speak. Let's start, the machine works. Why does it work? Because it was made to work, it could have failed at the first hurdle if we had the machine and we had no mechanics to turn it on – being very simplistic. Without going into detail, the reason why it will work is because it will be managed properly. The right resource base will have been structured, the right assessments and the environment for those will have been created so that we can pay due diligence to everything from quality, output, compatibility with the operators, etc. etc.

Measures :
quality, output,
operator friendly

Q. Do you have a system Joe?

We have a system and this is why, to be honest with you, should it be for assessment now before we had a system, albeit younger in experience, Industrial Engineers work study background, logical thinking people. Traditionally in this industry that was not always about, especially if you know the background history of our industry here where we have people here, 20, 30, 40, 60 years - we have a person retiring here after

60 years, can you imagine. So you can imagine the way things were done and of course time frame on top of that, and mistakes were made and judgements were made and it doesn't matter that mistakes were made because you were allowed to make mistakes and nobody assessed that you made mistakes and right the way through the whole chain things could happen. So this evolved that we had a logical approach anyway but it probably wasn't as formal as it could have been. So what we have this last two or three years, we have a more formalised, disciplined methodology and that in itself, we were doing roughly a third right in the past, it actually has unearthed two thirds underneath of things that we would never have considered. Like if you had of asked me, I'm sure a lot of Michael's analysis pays testament to that, myself included. I might of listed 25% to 30% of the likely measuring criteria for the successful acquisitional of technology of this sort so I suppose where we are at now I'm relatively confident that we have a system.

Acquisition Methodology

Q. Success in the past?

Can I ask you a question, why do you assume that we have been successful in the past?

Q. Because...?

That's because we have plenty of money. No, let me tell you – We're at expansion phase and when you look at returns at a very high level and very simplistically and if you knew our company, we actually consolidate our accounts into the States - but if take Europe as a separate operating entity, last year is actually the first year we've made any money and it could be questionable whether it was a bit of creative accounting in whatever we did.

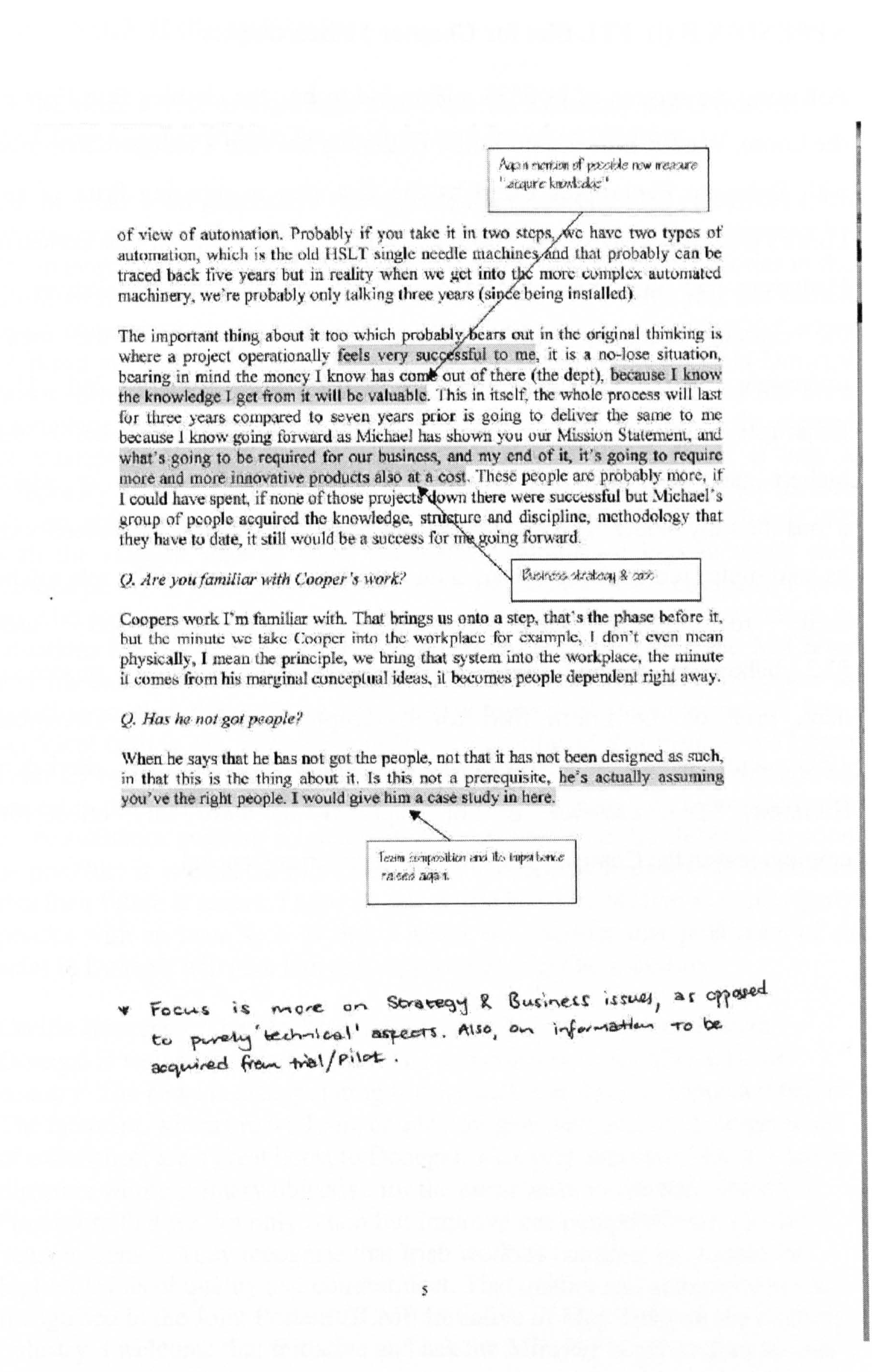
Q. So are you saying that you've been successful at spending on technology investment?

Measure - ROI

Yes, I would say in the last…. measured by return on investment. I'd rather have put my money in a building society if it had been me. We've been very good in the share price where people have made, and you only have to follow it, we have had fluctuations in the last ten years where our dollar value might have been $50 down to $17. But it's too complex an issue, but if you understood the way the company has been operated, structured, changed in the past.

It may be a bit challenging to you. You are making assumptions, it depends again on what measurement of success, if you measure going from 400 people to 3000 people and creating employment in the company then yes that is successful but that doesn't necessarily take it down to base, yes we got loads of grants from IDA/IDB. If the objective was setting up physical output – we were successful with that.

If you look within sewing which this particular project dwells, up until a few years back, we had probably 98% of the machines being utilised that were 35 years old in design, it was manual - the basics of basics. We probably now, traditionally in Ireland in the North-West, there's a lot of garment manufacturing although it's been declining.... We probably currently have this, from an automated point of view, nobody will touch us, even in Europe nobody will touch what we have from the point



of view of automation. Probably if you take it in two steps, we have two types of automation, which is the old HSLT single needle machines and that probably can be traced back five years but in reality when we get into the more complex automated machinery, we're probably only talking three years (since being installed).

The important thing about it too which probably bears out in the original thinking is where a project operationally feels very successful to me, it is a no-lose situation, bearing in mind the money I know has come out of there (the dept), because I know the knowledge I get from it will be valuable. This in itself, the whole process will last for three years compared to seven years prior is going to deliver the same to me because I know going forward as Michael has shown you our Mission Statement, and what's going to be required for our business, and my end of it, it's going to require more and more innovative products also at a cost. These people are probably more, if I could have spent, if none of those projects down there were successful but Michael's group of people acquired the knowledge, structure and discipline, methodology that they have to date, it still would be a success for me going forward.

Again mention of possible new measure "acquire knowledge"

Business strategy & cost

Q. Are you familiar with Cooper's work?

Coopers work I'm familiar with. That brings us onto a step, that's the phase before it, but the minute we take Cooper into the workplace for example, I don't even mean physically, I mean the principle, we bring that system into the workplace, the minute it comes from his marginal conceptual ideas, it becomes people dependent right away.

Q. Has he not got people?

When he says that he has not got the people, not that it has not been designed as such, in that this is the thing about it. Is this not a prerequisite, he's actually assuming you've the right people. I would give him a case study in here.

Team composition and its importance raised again.

- Focus is more on Strategy & Business issues, as opposed to purely 'technical' aspects. Also, on information to be acquired from trial/Pilot.

5

APPENDIX H (i) FTL files for Chapter 11 Bankruptcy

Following the success of its $835 million bid to buy the clothing firm Fruit of the Loom, Warren Buffett's Berkshire Hathaway has filed a reorganisation plan with Delaware Bankruptcy Court as the first step in repaying Fruit of the Loom's creditors. Fruit of the Loom announced at the weekend that Berkshire Hathaway had won the bankruptcy judge's approval for a takeover of the clothing company which controls about one-third of the men's underwear market in the United States. On January 2nd U.S. Bankruptcy Judge Peter Walsh declared Berkshire's bid "the highest and best offer", following a December 18th auction at which it was the only bidder. The decision allows Fruit of the Loom to proceed with its bankruptcy reorganisation plan, under which the proceeds of the sale will be used to repay some creditors' claims. Burdened with $1.2 billion in secured debt and about $500 million in unsecured debt, Fruit of the Loom filed for bankruptcy protection in December 1999, and agreed in November to be bought out by Berkshire Hathaway. The takeover is not expected to have any effect on employment in the Company's operations in counties Donegal.

APPENDIX H (ii) Dail Debate

Dr. McDaid: I wish to share time with Deputies Keaveney and O'Rourke.
An Ceann Comhairle Seán Treacy: I am sure that is satisfactory.

Dr. McDaid: I am grateful for the opportunity to make a brief contribution on what is regarded in Donegal as a very serious matter. Today's announcement by the management of Fruit of the Loom that most workers in its factories in the north west will soon work on short-time until the end of this year has caused much concern among its large staff. As the House will be aware the McCarters of Buncrana have made an enormous contribution to employment in Donegal down through the years and their relationship with their employees has been exemplary. The announcement mentioned various factors beyond the control of management which are responsible for what it is confident is only a temporary drop in demand for its products throughout Europe. They include the extraordinary unseasonable weather during recent months together [1740] with the sluggish state of many European economies. I kept in touch with various parties in Donegal today, including the director of the company. I have no wish to be alarmist because I am well aware that irresponsible comment in situations like this is not helpful. Today and in the coming days Mr. McCarter and his colleagues intend to discuss the position with as many employees as possible so that they will be kept fully informed of developments. I have sufficient faith in Mr. McCarter's ability to be confident that Fruit of the Loom is no fly by night company. His devotion to his native county is well known.I appeal to the Minister to do his utmost to ensure the company is provided with every assistance available to ensure that it can overcome this difficulty as soon as possible. It is essential that every effort is made to reassure the workforce that their future is secure. I hope no one would be so insensitive as to play party politics with an issue such as this. I assure the Minister that politicians of all sides in Donegal will give him any support that might be necessary.

Cecilia Keaveney: The McCarter family contribution to employment in Donegal is well recognised, appreciated and probably unparalleled in the country. The news is disappointing for the staff, but this has happened before. The factories, which are well run, employ diligent staff and produce garments of excellence, are a great boost to Donegal. This very successful team is led by directors whose primary objective for the north west, to use their words, is "to ensure that we not only retain but improve our competitiveness in the years to come". They recognise that Irish workers continue to provide the highest levels of quality and commitment. That quality and commitment was recognised in the Joint Forbairt/ICMF Initiative of May 1996 on the clothing industry. I welcome that initiative and ask the Minister to act on foot of that report. I should encourage and enable [1741] all existing and potential industries in Donegal to overcome any obstacles like those currently there to fulfil the last paragraph of his foreword in that document which states, "I am confident that, notwithstanding the intensity of the current competitiveness pressures, the Irish clothing industry can overcome these with the full support of Government and the development agencies, thereby securing a longterm viable future".

Fruit of the Loom is a great enterprise and I am confident that with an improvement in the market the current difficulties can be overcome.

Mrs. O'Rourke: I add my voice to that of my Donegal colleagues who have eloquently put their case. I was happy to visit all the Fruit of the Loom plants in the north one day about three years ago at the invitation of Mr. McCarter. While my Donegal colleagues have a greater knowledge of them, I was very impressed by the diligence, expertise and commitment of the staff, management and particularly of Willie McCarter and his family. I ask the Minister at this sensitive time to ensure due care is taken to focus on ever minute detail to assist the staff in that firm regain full-time employment. I understand there may be an opportunity for the Minister to contact Mr. Farrell in the US, who is involved in a parent company. He, in turn can give every encouragement to Fruit of the Loom Industries in the north-west. When one is as far away as he is, one leaves the running of the enterprise to the home management team. It is doing very well. However, it would be prudent for him to become involved in the long-term future of the firm and for all to work together to guarantee the much needed, highly acclaimed, highly skilled jobs which are greatly enjoyed by the mostly young population who work there.

Minister for Enterprise and Employment (Mr. R. Bruton): I thank the Deputies for raising this issue in the [1742] very restrained way in which they have, which is born out of their genuine concern for the position in Fruit of the Loom. I fully share their concern. Yesterday, Fruit of the Loom informed its workforce that it will be placing the bulk of its production workers on a three-day working week with effect from 1 July next. The company envisages that the short time working will last for the remainder of this year. In all about 3,000 workers are involved. This includes most of the Donegal workforce of 2,650, apart from administrative staff, about 200 workers in Derry and some 250 workers in Morocco.

I fully appreciate the concerns of all those involved and I also recognise that these concerns are heightened as this is the second time, within the past nine months or so, that Fruit of the Loom has been forced to introduce short-time working. The company's decision to introduce a three day working week was not taken lightly. I am aware, from the discussions I had last Friday with Fruit of the Loom's Managing Director, Mr. William McCarter, that the company gave very careful and detailed consideration to the matter before reluctantly arriving at its decision. Fruit of the Loom has been forced to take this action, as the anticipated level of sales for 1996 was not coming up to expectations. While the company is continuing to hold its existing market share, it had been planning to increase this level during the current year. However, a number of factors beyond its control has resulted in the company not realising its growth targets. These include, the continuing sluggishness of the European market, a bad spring, and a slow tourist trade in continental Europe. Fruit of the Loom, therefore, was left with no option but to respond to the negative impact these factors have had on its sales. Consequently the company decided to address the current difficulties by reducing output through a temporary [1743] period of short time working to control its inventory growth.

Obviously this is a disappointing development for Fruit of the Loom. I am sure, however, that the Deputies will appreciate that the company must react to the market situation. In all of the circumstances, they have concluded it was better that the necessary corrective action be taken now, by way of short-time working, rather than later when the situation might be far more difficult to correct.

As Fruit of the Loom is the single largest employer in the north-west, the company's decision to go on short-time working will naturally have a significant impact on the entire region, not alone on the workers and their families, but also on the local economy on both sides of the Border.

I am aware that Fruit of the Loom's managing director has written to all of its employees, explaining the position. In addition he has discussed the situation with the union representatives. I understand the company's management will continue to keep everybody apprised of developments.

Deputies will appreciate that this is a trying and difficult time for everybody connected with Fruit of the Loom, management and workers alike.

Everybody, including members of this House should [1744] work together in the efforts being made by the company to overcome its current difficulties.

I assure the House that IDA Ireland will continue to work closely with Fruit of the Loom during this difficult period and, that the IDA intends to continue to market aggressively the north-west region as a suitable location for additional industrial developments.

I am advised by the IDA that we should enter discussions with the US parent companies, and with Mr. Bill Farrell in particular. I am certainly open to that suggestion. I will obviously be guided, in the first instance, by the IDA and by Mr. William McCarter who is dealing at first hand with this problem. I can also assure Deputy Keaveney there is available to Fruit of the Loom assistance with research and development and product development to assist the company in addressing the problems it faces. The present difficulties are not due to problems with the product but to a downturn in the market compared to expectations. I have already met Mr. William McCarter. I had a special briefing with the IDA today, and I am determined to ensure the IDA does everything possible to assist this company overcome its present difficulties.

The Dáil adjourned at 9.10 p.m. until 10.30 a.m. on Wednesday, 12 June 1996.

APPENDIX H (iii) Fruit of the Loom directors agree $2m severance package.

By EIBHIR MULQUEEN (Irish Times, 30th August 1997).

The dispute between three directors of Fruit of the Loom's Irish operations and the parent company has been was resolved. The settlement terms are not being disclosed but it is understood that a redundancy package amounting to around $2 million (£1.3 million) was agreed between the two parties following an adjourned High Court hearing yesterday morning. This does not include the pension settlement and other entitlements. Mr William McCarter, managing director, Mr John McCarter, sales director and Mr Seamus McEleney, finance director, will resign from the company on September 30th, according to the statement issued on behalf of both parties.

The statement was drawn up in the presence of lawyers for each side after a decision was made on May 29th to remove the directors as part of a European restructuring programme. Fruit of the Loom has stated that the three positions will not be filled. The court action began when they applied for an injunction to block the redundancy move.

Yesterday's statement says that "all parties have agreed that no details of the settlement will be disclosed". However, it is reliably understood that $2 million was agreed as a final redundancy figure. Mr William McCarter, who has been associated with the company for 26 years, will receive the larger share of the payoff, as well as considerable pension entitlements. The current chairman of the International Fund for Ireland, he has been managing director since 1972 and was joined by his brothers, John and Andy, six years later.

Their father, who was also involved in the business, had advised his sons not to get involved, saying that there were "easier ways of making money", Mr Willie McCarter said in an interview with The Irish Times in 1988.

A year before, the 60-year-old Buncrana company, which was founded by the McCarters' uncle, was acquired by the Chicago-based Fruit of the Loom company.

Asked if he was sad at leaving the company after his long association with it, William McCarter was philosophical yesterday, saying: "Well, that's life." A spokesman at the SIPTU branch office in Letterkenny said members were sorry to see the "local directors" leaving. "They were genuinely committed to Donegal and to employment in Donegal," he said. Earlier this month, almost half of the 3,500 employees signed a petition urging the parent company not to remove the three directors and saying that "people's hopes within our small community have been dealt a severe blow and we feel that if there is any possibility of reinstatement it would go a long way to restoring that much needed hope".

The statement from both parties said they were pleased that an agreement had been reached. "We wish to assure all of the employees at Fruit of the Loom in Donegal and Derry that it has, and will continue to be business as usual," it said.

The three outgoing directors said that they were pleased that Mr Andy McCarter and Ms Mary Cullen, the two remaining directors, would continue with the company. Mr McCarter will take over the running of the Irish operations and Ms Cullen will have an enhanced role. The dispute became protracted after a series of severance offers to the three directors were rejected. A recent one is believed to have been worth more than $1 million (£680,000).

A spokesman for the company said the parties reached agreement at 2 p.m. after their legal representatives had asked at yesterday morning's hearing that the case be put in for mention in the afternoon. When the case came up, Mr Ercus Stewart SC, counsel for the company, and Mr Tom Mallon, counsel for the directors, asked that the matter be struck out with no further order. A spokesman for the three directors said they would have preferred to have remained with the company but that, in the circumstances, they believed the settlement was in the interests of themselves, the employees and the company. The three will now "take a break".

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